PB-229 093

TENNESSEE RIVER DRAINAGE BASIN

Public Health Service
Cincinnati, Ohio

1951

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 229 093

SUMMARY REPORT ON WATER POLLUTION

Tennessee River Drainage Basin

Prepared by

FEDERAL SECURITY AGENCY
Public Health Service
Division of Water Pollution Control
Ohio and Tennessee Drainage Basins Office

1951

COLOR ILLUSTRATIONS REPRODUCED
IN BLACK AND WHITE

On the basis of information
supplied by:

Alabama State Department of Health
Georgia State Department of Health
Kentucky Water Pollution Control Commission
Mississippi State Board of Health
North Carolina State Board of Health
Tennessee Stream Pollution Control Board
Virginia State Water Control Board

Tennessee Valley Authority

136

i.

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

Public Health Service Publication No. 69

WASHINGTON: 1951

1a

Contents

Part I - TENNESSEE RIVER DRAINAGE BASIN REPORT

Introduction -- 1
Acknowledgments -- 3
Summary -- 5
Conclusions -- 9
Recommendations -- 12
General Description -- 13
  Historical Background ------------------------ 13
  Physical Characteristics ------------------------ 13
  Climate-Hydrology ------------------------ 16
  Economic Development ------------------------ 16
Uses of Water Resources -- 19
Pollution Contributed to Water Resources --------------- 21
Damages to Water Resources from Pollution ------------ 26
Benefits Resulting from Pollution Prevention and Abatement -- 29
Pollution Prevention Measures in Effect ---------------- 30
Pollution Prevention Measures Required ---------------- 38

Maps

Location Map - Tennessee River Drainage Basin --------- f. 13
Sources of Pollution ---------------------------------- f. 13
Existing Treatment Works ---------------------------- f. 13
Project Requirements ---------------------------- f. 13
Existing Primary Water Uses ------------------------ f. 13

Tables

Table A - Sources of Pollution - Municipal -------------- 24
Table B - Sources of Pollution - Industrial -------------- 25
Table C - Existing Treatment Facilities - Municipal ------ 35
Table D - Existing Treatment Facilities - Industrial ------ 36
Table E - Adequacy of Existing Treatment Facilities ------ 37
Table F - Progress in Pollution Abatement -------------- 37
Table G - Requirements for Municipal and Industrial Waste Treatment Plants ------------------------ 42
Table H - Status of Treatment Works Projects to Abate Pollution ---------------------------------- 42

Part II - SUB-BASIN REPORTS *

Tennessee River Main Stem and Minor Tributaries Sub-Basin
(Alabama, Georgia, Kentucky, Mississippi, Tennessee)
Description ---------------------------------- 44
Tables --- -------------------------------- 47

Holston River Sub-Basin
(North Carolina, Tennessee, Virginia)
Description -------------------------------- 57
Tables ------------------------------------- 60

French Broad River Sub-Basin
(North Carolina, Tennessee)
Description -------------------------------- 69
Tables ------------------------------------- 72

Little Tennessee River Sub-Basin
(Georgia, North Carolina, Tennessee)
Description -------------------------------- 78
Tables ------------------------------------- 81

Clinch River Sub-Basin
(Tennessee, Virginia)
Description -------------------------------- 86
Tables ---- -------- ----------------------- 90

Hiwassee River Sub-Basin
(Georgia, North Carolina, Tennessee)
Description -------------------------------- 99
Tables ------------------------------------- 101

Elk River Sub-Basin
(Alabama, Tennessee)
Description -------------------------------- 107
Tables ------------------------------------- 109

Duck River Sub-Basin
(Tennessee)
Description -------------------------------- 114
Tables ------------------------------------- 117

---

* Each Sub-Basin Report includes Tables A through H, and "Table I - Project List - Municipalities and Industries Requiring Improvements for Abatement of Pollution."

INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June of 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies, and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters.

In developing these programs, due regard must be given to improvements necessary to conserve the Nation's waters for public water supplies, propagation of fish and aquatic life, recreational purposes, agricultural, industrial, and other legitimate uses.

Recognizing the fact that full technical information was not available to permit the development of such comprehensive programs immediately for most of the Nation's waters, the Public Health Service envisioned the development of these programs in two general phases. The first phase contemplated the development of a series of reports, consistent with presently available data, which would: provide a reference point for measuring progress; provide a guide to needed additional data; provide a basis for the logical development of comprehensive programs; provide a basis for approval of loans to States, interstate agencies and municipalities at such time as the Congress made available funds for this purpose; and serve to inform the public on the problem of water pollution and set forth suggestions for pollution control.

The collection of available data as of July 1, 1950, has been completed under the first phase of the program. Such data have been assembled with the cooperation of State and interstate water pollution control agencies. Through these agencies additional data have been obtained from other State officials, county and city officials and representatives of industry. Federal agencies also have been of great assistance. In order to make this information available at the earliest possible moment, these data are being presented in 15 summary-type reports covering the United States by major drainage basins. This report on the Tennessee River Basin is one of that series.

These summary reports present information about the ways our water resources are used, the pollution going into our water resources and the resulting damages, the benefits which may result from pollution prevention and abatement, the pollution prevention measures now in effect, and those required.

They are prepared in two parts. Part one considers the water pollution problems of the basin as a whole. Part two presents briefly the data for each of the several sub-basins of the major basin, including a list of projects now known to be needed for water pollution control.

Since the summary reports are based on data which are now readily available, these reports do not discuss or evaluate the most advantageous water uses as they are related to pollution control. Such considerations will be included as a part of the comprehensive water pollution control programs.

The deficiencies in data and the gaps in information indicated in these summary reports are as significant as the presentation of available facts and statistics. They indicate the work which still needs to be accomplished by water pollution control authorities for the preparation of comprehensive programs.

Data and knowledge now available are sufficient, however, to permit the immediate solution of many of the pollution problems within the Tennessee Basin without awaiting the results of additional surveys and studies. The tabulations of pollution abatement projects which are included in Part Two of this summary report represent presently known needs. However, future studies and evaluations may result in some changes in the estimations of requirements.

A sincere effort has been made by all who contributed to this report to present a fair picture of the complex water pollution problems in the Tennessee Basin and to present reasonable conclusions and recommendations. It is our hope that this report, as a step in the cooperative development of an ultimate comprehensive pollution control program, will help in safeguarding the water resources of the Tennessee Basin.

Leonard A. Scheele

Surgeon General

ACKNOWLEDGMENTS

The Public Health Service wishes to acknowledge the cooperation and assistance of those agencies and individuals which have contributed to the preparation of this report.

The water pollution control agencies of the States in the Basin, including the Virginia State Water Control Board, the North Carolina State Board of Health, the Tennessee Stream Pollution Control Board, the Alabama State Department of Health, the Mississippi State Board of Health, the Kentucky Water Pollution Control Commission, and the Georgia State Department of Health, have furnished the data from which the various tables were prepared and other data and information contained in the narrative statements. These agencies have also reviewed the preliminary draft of the report and have offered valuable comments and suggested changes. In general, the preliminary draft has been revised so that the report is in agreement with the comments and suggestions of the State agencies, with the exception that the Director of Water Pollution Control, Georgia Department of Public Health, has advised that statements in paragraphs 4 and 7 of the Conclusions, and related paragraphs in the Recommendations, do not apply to Georgia.

Federal agencies from which assistance was obtained include the Corps of Engineers, Department of the Army, and the Fish and Wildlife Service and Geological Survey, Department of the Interior.

Special recognition is given to use of data obtained by the Tennessee Valley Authority, some of which was made available directly from publications of that Agency and some being furnished through the various water pollution control agencies of the States.

Recognition is also given to use of basic information contained in the Ohio River Pollution Control Survey, prepared jointly by the Corps of Engineers and the Public Health Service and published as House Document No. 266, 78th Congress, 1st Session. This report also served as a valuable comparison between present conditions and those of a decade ago.

Finally, there is acknowledged the assistance of other State agencies and individuals interested in water resources development and conservation, who have contributed information through other sources than those listed above.

SUMMARY

The Tennessee River Basin has a total drainage area of 40,910 square miles and drains parts of the States of Virginia, North Carolina, Tennessee, Georgia, Alabama, Mississippi, and Kentucky. The population of the basin approximated 2,500,000 as of 1940, of which about 75 percent was rural and the remainder urban. The upper portion of the basin is rugged and mountainous and well timbered except in the valleys. The lower portion is composed of plateaus and rolling plains in which agricultural pursuits predominate.

The Tennessee Valley Authority has, through water resources development and management, completely changed the characteristics of the main stem and lower portions of the major tributaries from those common to free flowing streams to those prevailing in lakes and large impoundments. Stream flows are controlled and regulated for the primary purposes of flood control and navigation, with the secondary purpose of power generation. Although stream regulation necessary to alleviate the effects of pollution is not provided for in the Act creating the Authority, reservoir and stream management operations have in special instances provided for some stream regulation in the interest of pollution abatement. There is a need for special studies to consider the benefits of a policy and to determine the effects, both adverse and beneficial, of changed stream conditions on the overall pollution control problem.

The Tennessee River Basin is rich in natural resources and, although the population is predominately rural, almost every type of industry is found within the area. Rapid industrial expansion has followed as hydroelectric power has been developed by the TVA.

Recreation of a type associated with water uses is rapidly becoming one of the leading business enterprises in the basin. The basin has almost unlimited potentialities for expanding such facilities, provided the many miles of polluted streams and reservoir shoreline can be restored to a usable condition.

The quantity of ground water which can be developed throughout most of the area is limited. Surface waters are generally abundant and must be relied upon to furnish large domestic and industrial requirements.

There are 201 municipal and 148 industrial waste outfalls contributing significant amounts of pollution to the streams of the basin. The organic pollution load discharged to the streams from 185 municipalities and 87 industrial waste outfalls is equivalent to the wastes from 2,482,000 people, or approximately equal to the total population of the basin. Industrial wastes discharged to municipal sewers and through separate outfalls account for at least two-thirds of the total organic pollution. Sixteen municipalities and 15 industries are discharging organic wastes, the population equivalent of which is undetermined. Pulp and paper, chemical and textile industries contribute the major portion of the organic industrial waste load to the basin, and chemical plants are also the major contributors of inorganic wastes which adversely affect water uses.

The total organic pollution load has increased by at least 35 percent during the past decade despite the corrective action taken by some few but important industries.

The Holston, French Broad, Pigeon and Clinch Rivers, together with the upper portion of the Tennessee River, are the most seriously affected by pollution. These same drainage areas hold the greatest promise for future recreational development. All of these streams are interstate waters. Pollution arising in one State seriously affects water uses in the downstream States.

Pollution exerts damaging effects on all water uses throughout the basin, particularly public and domestic water supplies, bathing and fishing. Chemical plant wastes contribute excessive amounts of hardness, chlorides and sulphates to the Holston River resulting in impairment to the water quality as far away as Knoxville, Tenn., below the mouth of the Holston. Industrial and domestic pollution discharged near the headwaters of the French Broad and Pigeon Rivers make these streams unsuitable for sources of public and industrial water supply. Silt and chemical wastes have damaged fish life along Nolichucky and Duck Rivers. Domestic and industrial pollution from the Knoxville and Chattanooga, Tenn. areas has damaged fishing, bathing and recreational uses on the main stem of the Tennessee for several miles below these cities. The use of these waters for public and industrial water supplies is also jeopardized.

All water uses will benefit by pollution abatement and the judicious use of the water courses for the final disposal of sewage and industrail wastes.

Existing pollution prevention measures have little effect in correcting or reducing overall pollution in the basin. One hundred and twenty-two of the 201 municipal sources of pollution discharge untreated sewage into the streams of the basin. The population of these 122 municipalities is 80 percent of the population living in sewered communities. Although 57 municipalities have primary treatment works and 21 have secondary treatment works, only 32 treatment plants are considered satisfactory, and only 8 percent of the sewered population are tributary to adequate treatment facilities. Only 13 of the 148 industries contributing wastes through separate outfalls have adequate treatment facilities and only 2 of these plants are treating organic wastes. Thirty-four municipalities and 13 industries have unsatisfactory treatment facilities, while the needs of 12 municipal treatment plants and 13 industrial waste treatment plants are undetermined. Six industrial plants not listed as having satisfactory treatment can correct the situation by means other than installation of waste treatment facilities.

Comparatively little construction of the pollution abatement works has been undertaken during the postwar period in the Tennessee River Basin. Two municipal waste treatment plants with a total design population of 12,600, and ten industrial plants designed to treat a waste having an equivalent population of 108,000, have been constructed from 1946 to 1949 inclusive.

On the basis of the existing data, new treatment plants are required for 102 municipal sources of pollution and 83 industrial sources now discharging througn separate outfalls. Thirty-three municipal sources and 9 industrial sources require either improvement or replacement of existing plants. The needs at 34 municipalities and 37 industries are as yet undetermined. Corrective measures have been initiated for 43 municipal sources of pollution, while 41 industrial sources have taken steps to abate their pollution. These proposed improvements will treat more than half of the pollution load now discharging to the streams of the basin.

While some States have adequate and comprehensive water pollution control statutes, a few States are very limited in their authority to reduce or abate existing pollution and to prevent new pollution from being discharged to the streams. There is no inter-State compact between the States in the Tennessee River Basin on matters relating to water pollution.

On the basis of available data which are admittedly incomplete, the total initial cost of required municipal and industrial waste treatment facilities, including intercepting sewers, is estimated at from $47,000,000 to $57,000,000.

CONCLUSIONS

1. The water resources of the Tennessee River Basin have been highly developed for flood control, navigation and power development by the Tennessee Valley Authority. The development and management of the Tennessee River system by the TVA for these purposes have a profound impact on the pollution control problems, both in the effect (adverse and beneficial) on available dilution and on the biological, physical and chemical characteristics of the waters so controlled. Policies concerning low flow requirements compatible with pollution abatement have not been established in the stream management program.

2. The data included in the report are reasonably complete and adequate insofar as municipal sources of pollution are concerned. In some instances, however, industrial waste loads tributary to municipal sewerage systems and their effects on domestic sewage treatment processes are not too well defined. Information on industrial wastes discharged through separate outfalls is not so adequate; nor are the effects and damages of pollution on various sections of the streams fully determined. However, the data and knowledge are sufficient to permit immediate action in providing abatement works at many pollutional sources without awaiting the results of additional surveys and studies.

3. New waste treatment facilities are required at a large majority of both municipal and industrial sources of pollution. Although there has been but little pollution abatement construction during the postwar period, the State water pollution control agencies have recorded progress through stimulating the planning of municipal treatment works and by defining the needs of an effective abatement program. Some industries have recognized their responsibilities and have made substantial progress in reducing their pollution principally by plant process changes. Research and studies on methods of industrial waste treatment are also being undertaken.

4. Much of the pollution, domestic and industrial, is discharged into the headwaters of the upper tributaries and the upper portion of the main stem of the Tennessee River. These streams are all interstate waters, and pollution arising in one State is affecting the legitimate water uses in adjoining States. This presents a serious

interstate pollution control problem, the solution of which is not provided for in the water pollution control legislation of the affected States.

5. Pollution from untreated or inadequately treated domestic sewage has created public health hazards which are distributed throughout the basin. Many miles of streams are polluted to the extent that bathing cannot be condoned because of public health dangers. Bacterial pollution has resulted in overloading several water treatment plants beyond accepted safe limits and has made many surface waters unsafe for public water supply sources.

6. The natural resources of the basin, together with the water resources development program, assure continued industrial expansion, accelerated development of recreational potentialities, and a corresponding increase in the supporting population, provided the required water needs can be supplied. Pollution has already made large stretches of the basin's watercourses unfit as sources for public and industrial water supplies, and for many recreational uses including bathing and fish and aquatic life propagation. Continued abuse of the waters' use for uncontrolled waste disposal will not only make additional public waters unfit for desirable uses, but will definitely retard economic advancements for which the existing water resources development program was created and for which the area is particularly adapted.

7. Factors which have retarded pollution abatement accomplishments in the Tennessee River Basin include: (1) Lack of adequate comprehensive State water pollution control legislation, (2) lack of interstate agreements to cope with interstate pollution problems, (3) lack of knowledge concerning satisfactory methods for treating certain complex industrial wastes, and (4) inadequate funds to maintain essential professional staffs in State water pollution control agencies.

8. Reduction of pollution by the required waste treatment facilities will benefit all other legitimate water uses and will permit the full utilization of the water resources essential to serve the needs of an increasing population, further industrial expansion, and the maximum development of recreational potentialities.

Note: The Director of Water Pollution Control, Georgia Department of Public Health, makes the following request, "I am requesting that

you indicate clearly in the section of the Report headed Conclusions that statements made particularly in numbered paragraphs 4 and 6 on page 7 (page 9, paragraphs 4 and 7 of final draft) do not apply to Georgia. This request extends also to any statements in the section headed Recommendations based on the above numbered paragraphs in your Conclusions."

RECOMMENDATIONS

1. It is recommended that municipalities and industries assume their responsibilities for restoring and preserving the waters of the basin, essential for the maximum development of the basin's resources, and initiate the construction of the pollution abatement projects now required.

2. It is recommended that the States and the Tennessee Valley Authority undertake a cooperative study designed to integrate benefits for pollution abatement with stream management practices. Consideration should be given to the benefits to be derived by providing sustained low stream flows consistent with practical waste treatment requirements and reasonable use of the waters for final waste disposal. The effects on self-purification processes resulting from the changed stream characteristics should also be better defined.

3. It is recommended that the resources of all State water pollution control agencies be expanded consistent with their needs to obtain information now missing on sources and amounts of pollution, and the effects of pollution on water quality and water uses, and to provide adequate supervisory control over treatment plant operation.

4. It is recommended that comprehensive State water pollution control legislation be adopted by those States not now having adequate control authority. Such legislation should provide for the formation of interstate compacts for the control of interstate pollution problems.

5. It is recommended that educational programs, designed to make the public more cognizant of the damages accruing from pollution and the benefits to be derived from its reduction, be continued and expanded.

6. It is recommended that research be accelerated on the treatment of wastes for which there is now no known practical treatment process.

LOCATION MAP

A

Tennessee River Drainage Basin

12a

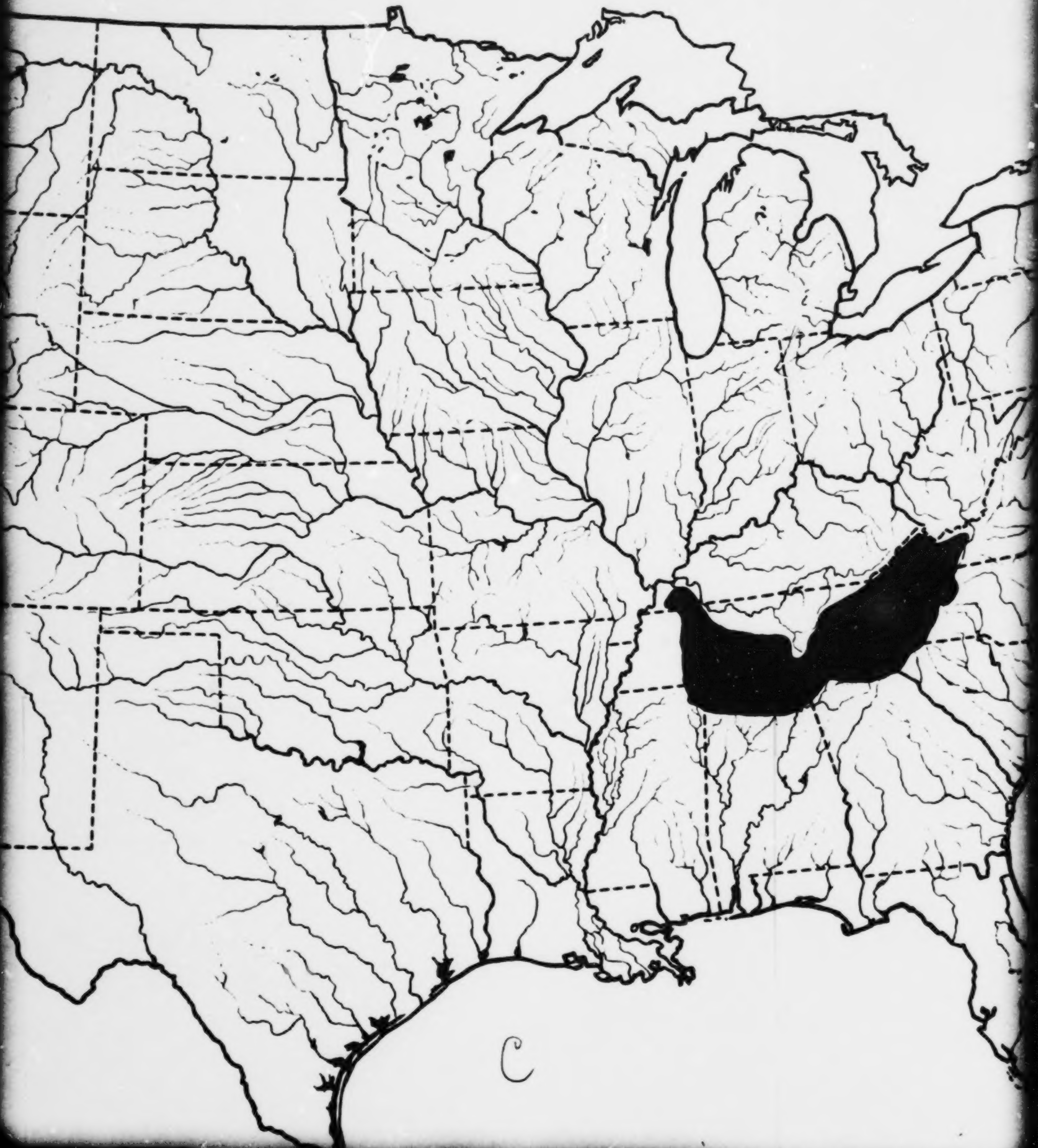
LOC

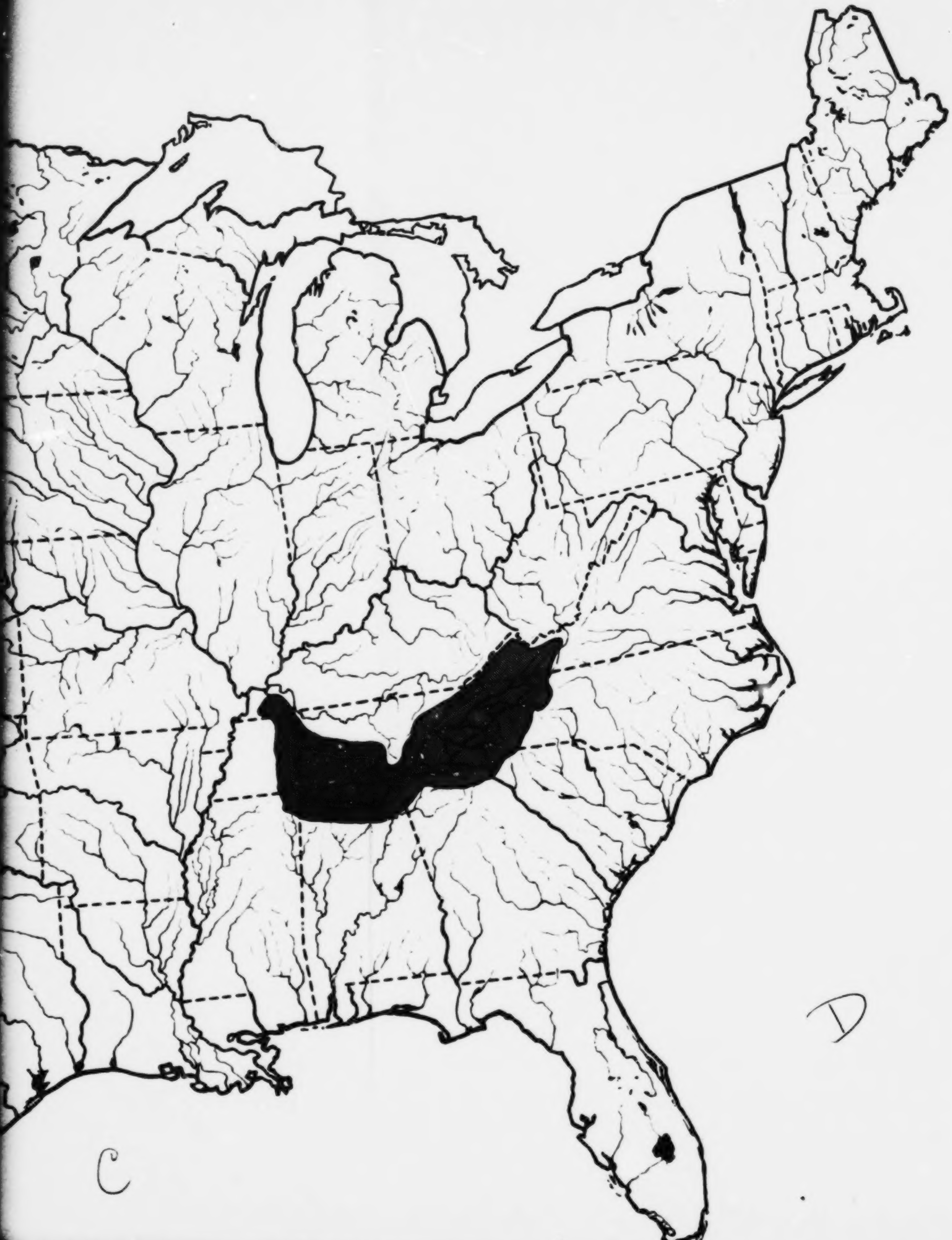
A

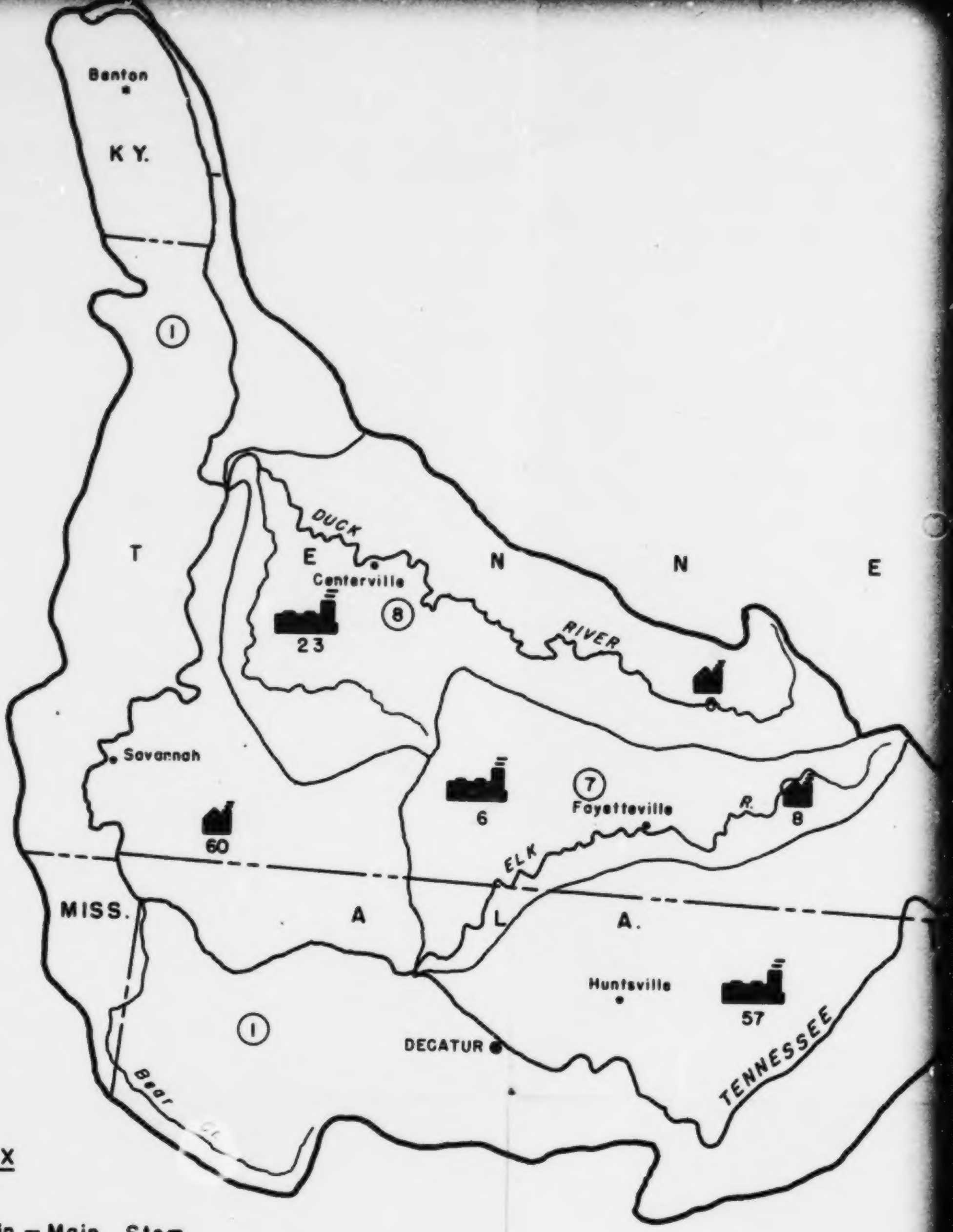
Tennessee

B

12a




D
C


Benton
KY.
1
T
E
N
N
E
DUCK
RIVER
Centerville
8
23
Savannah
60
6
7
Fayetteville
R.
8
ELK
MISS.
A
L
A.
Huntsville
57
1
DECATUR
Bear Cr.
TENNESSEE

SUB-BASIN INDEX

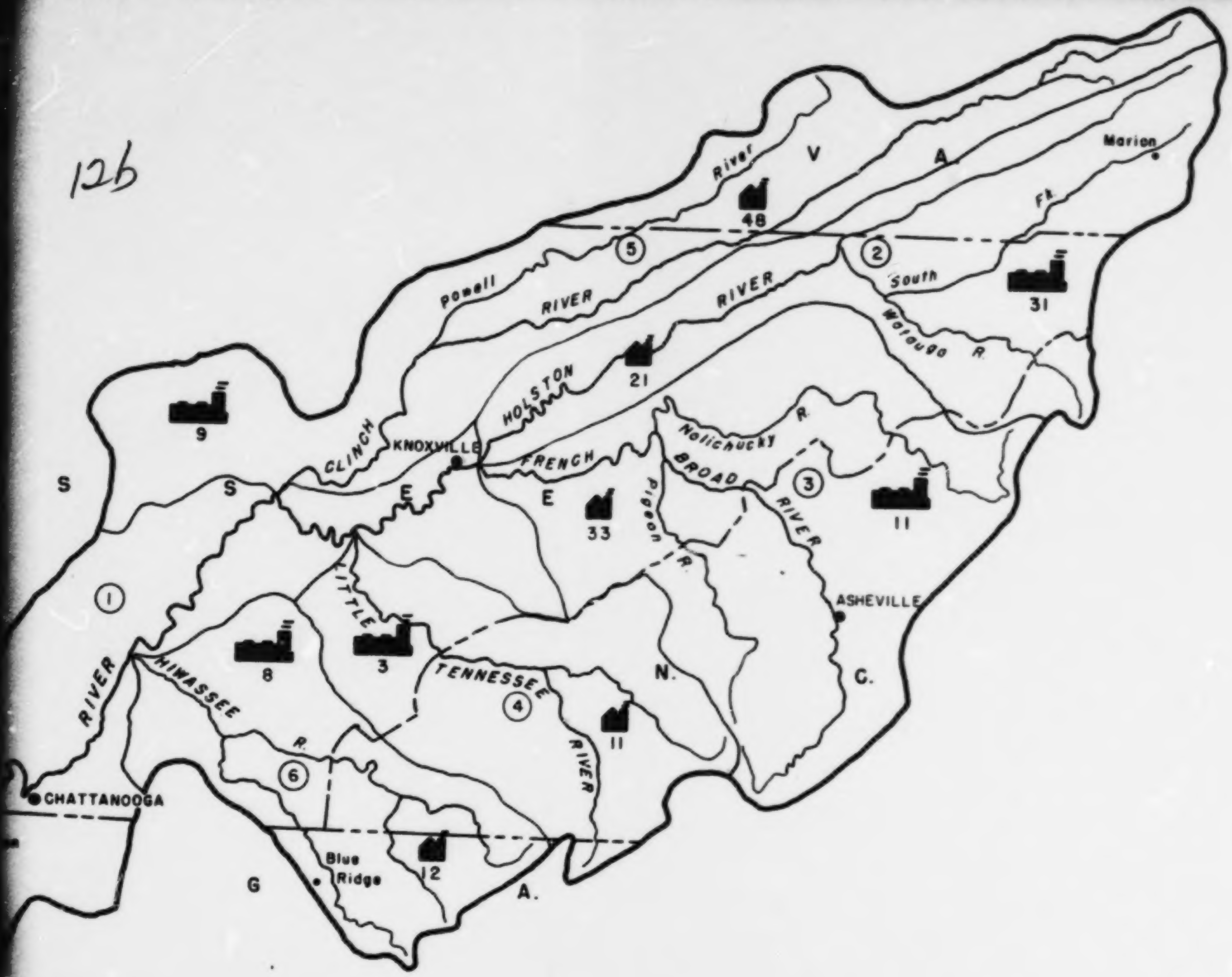
① Tennessee River Basin - Main Stem
② Holston River Basin
③ French Broad River Basin
④ Little Tennessee River Basin
⑤ Clinch River Basin
⑥ Hiwassee River Basin
⑦ Elk River Basin
⑧ Duck River Basin

A

NUMBER OF MUNICIPAL SOURCES

NUMBER OF INDUSTRIAL SOURCES

12b


Marion
V
A
River
48
Fk.
5
2
South
31
Powell
RIVER
RIVER
Watauga R.
HOLSTON
21
9
CLINCH
KNOXVILLE
Nolichucky R.
FRENCH
S
S
E
E
BROAD
3
33
Pigeon R.
RIVER
11
1
LITTLE
ASHEVILLE
8
3
RIVER
HIWASSEE
TENNESSEE
4
N.
C.
R.
RIVER
11
6
CHATTANOOGA
Blue Ridge
12
G
A.

B

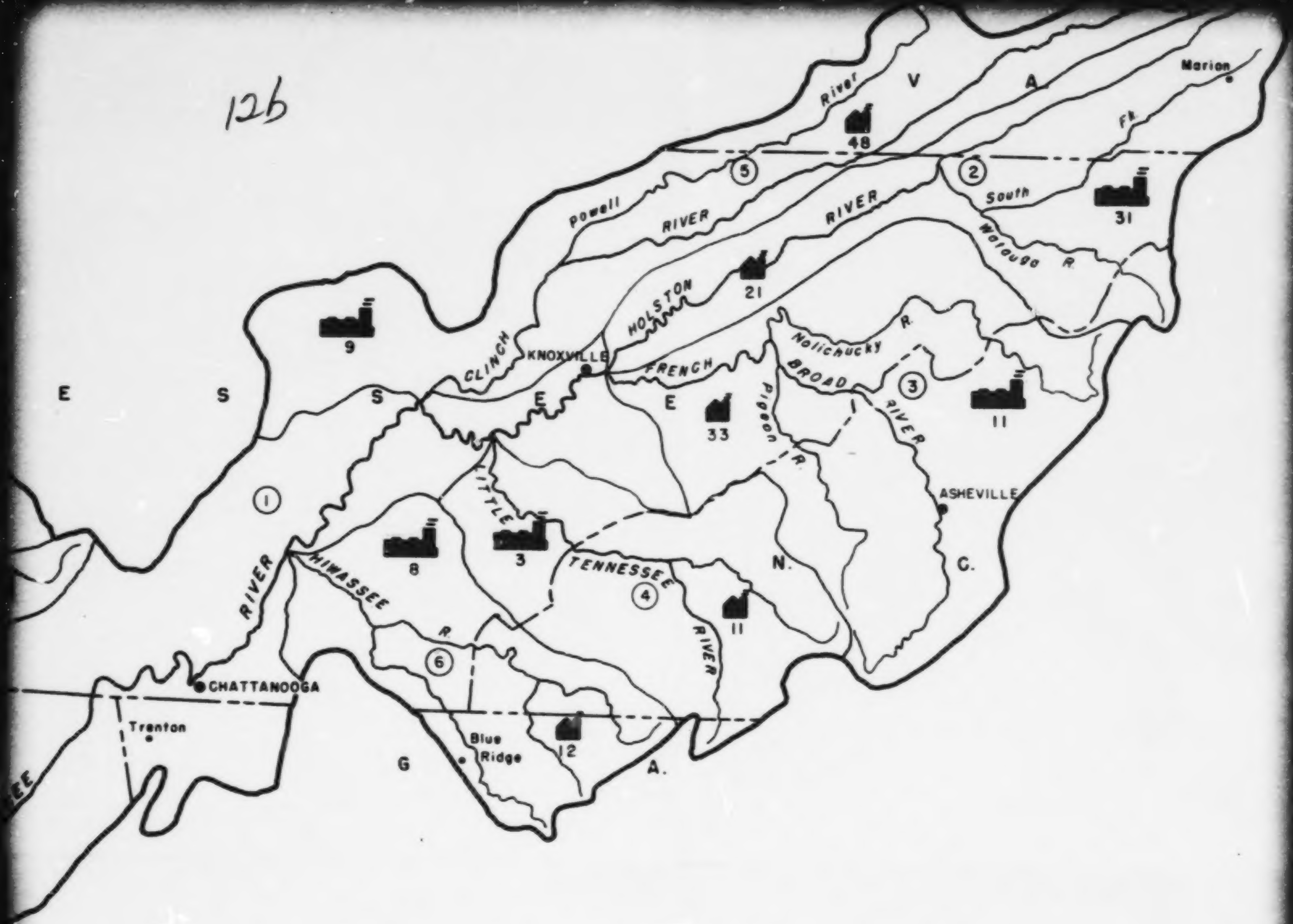
TENNESSEE RIVER DRAINAGE BASI

SOURCES OF POLLUTION

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL

MAP NO. 1

12b


V
A
Marion
River
48
Fk.
5
2
South
31
Powell
RIVER
RIVER
Watauga R.
HOLSTON
21
9
CLINCH
KNOXVILLE
FRENCH
Nolichucky R.
BROAD
3
11
E
S
S
E
E
33
Pigeon R.
RIVER
1
ASHEVILLE
LITTLE
8
3
TENNESSEE
4
N.
C.
RIVER
HIWASSEE
R.
11
RIVER
6
CHATTANOOGA
Trenton
Blue Ridge
12
G
A.
RIVER

B

TENNESSEE RIVER DRAI

SOURCES OF PO

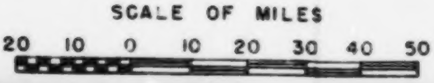
FEDERAL SECURITY

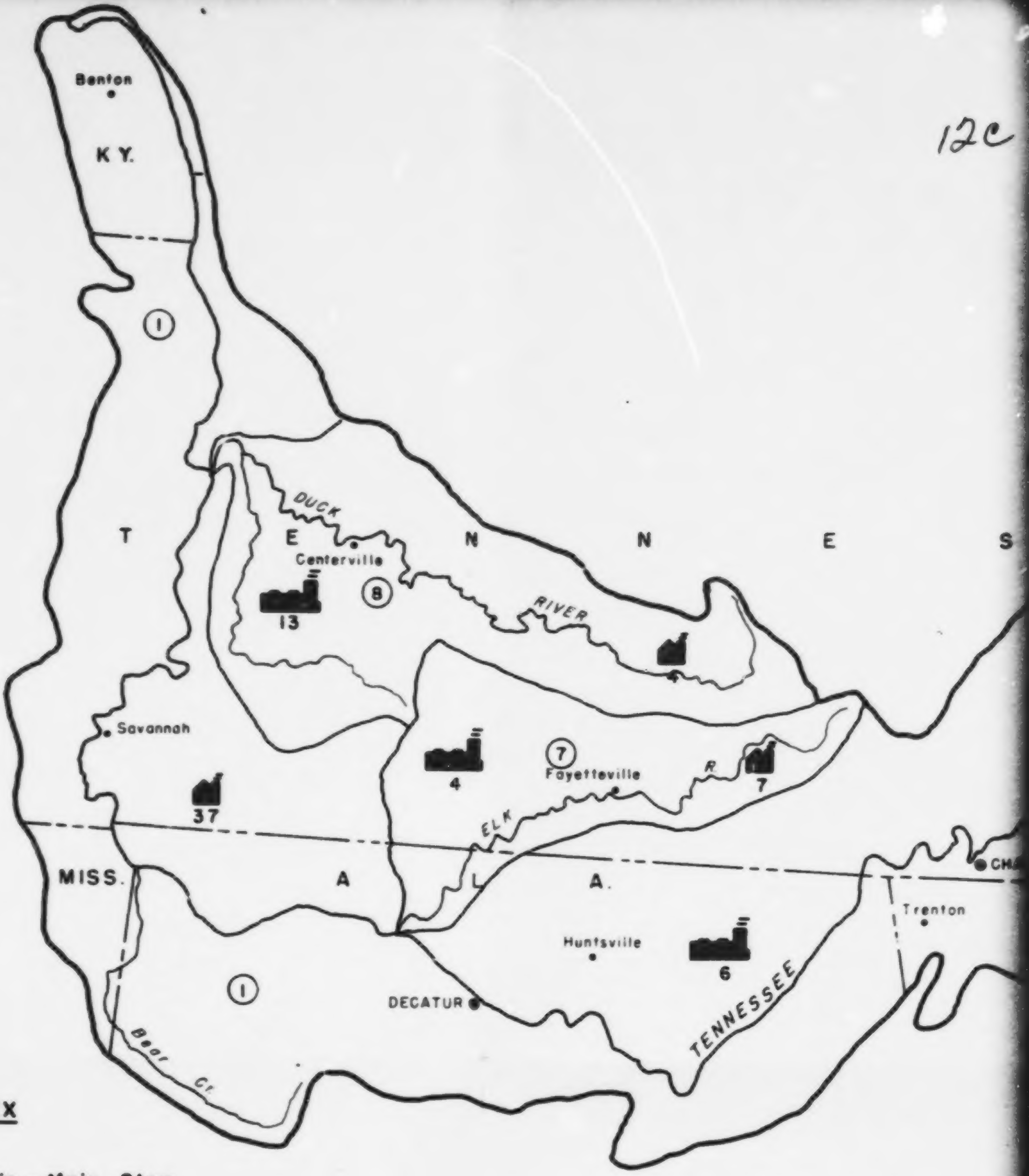
Public Health Ser

DIVISION OF WATER POLLUT

MAP NO. 1

C


SCALE OF MILES
20 10 0 10 20 30 40 50


Benton
KY.
①
T E N N E S
DUCK RIVER
Centerville
⑧
13
4
Savannah
37
⑦
Fayetteville
ELK R
4
7
MISS.
A L A.
CHA
Trenton
Huntsville
6
①
DECATUR
Bear Cr.
TENNESSEE

SUB—BASIN INDEX

① Tennessee River Basin – Main Stem

② Holston River Basin

③ French Broad River Basin

④ Little Tennessee River Basin

⑤ Clinch River Basin

⑥ Hiwassee River Basin

⑦ Elk River Basin

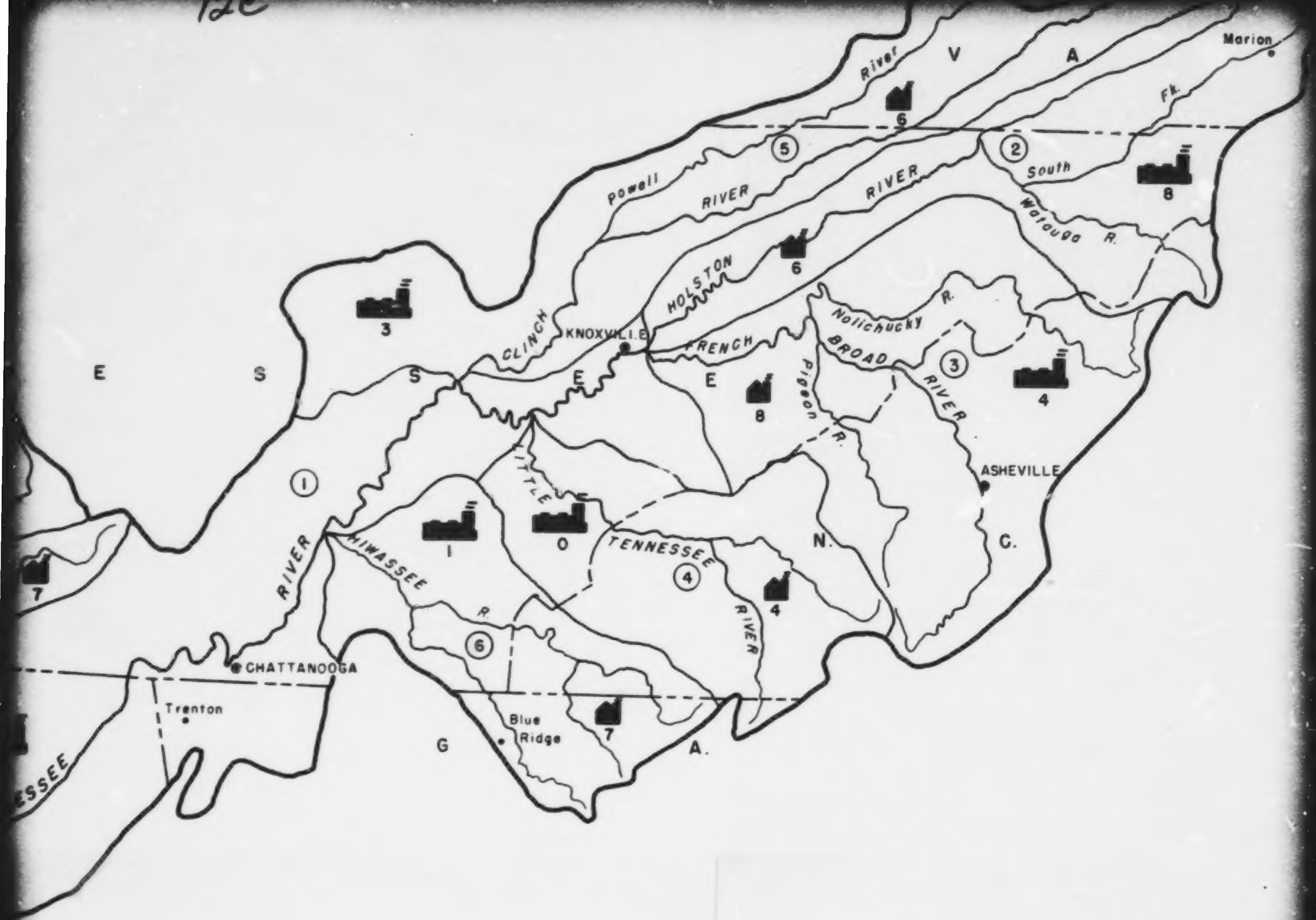
⑧ Duck River Basin

A

■ *NUMBER OF EXISTING MUNICIPAL TREATMENT WORKS*

▬ *NUMBER OF EXISTING INDUSTRIAL TREATMENT WORKS*

12e



Marion
River
V
A
6
5
2
South
Fk.
8
Powell
RIVER
RIVER
Watauga R.
HOLSTON
6
3
CLINCH
KNOXVILLE
Nolichucky R.
FRENCH
E
S
S
E
BROAD
3
RIVER
4
E
8
Pigeon R.
ASHEVILLE
1
LITTLE
1
0
TENNESSEE
4
N.
C.
7
RIVER
HIWASSEE
R.
RIVER
4
6
CHATTANOOGA
Trenton
Blue Ridge
7
G
A.
ESSEE

B

TENNESSEE RIVER DR

EXISTING TREATM

FEDERAL SECURITY

Public Health

DIVISION OF WATER POLL

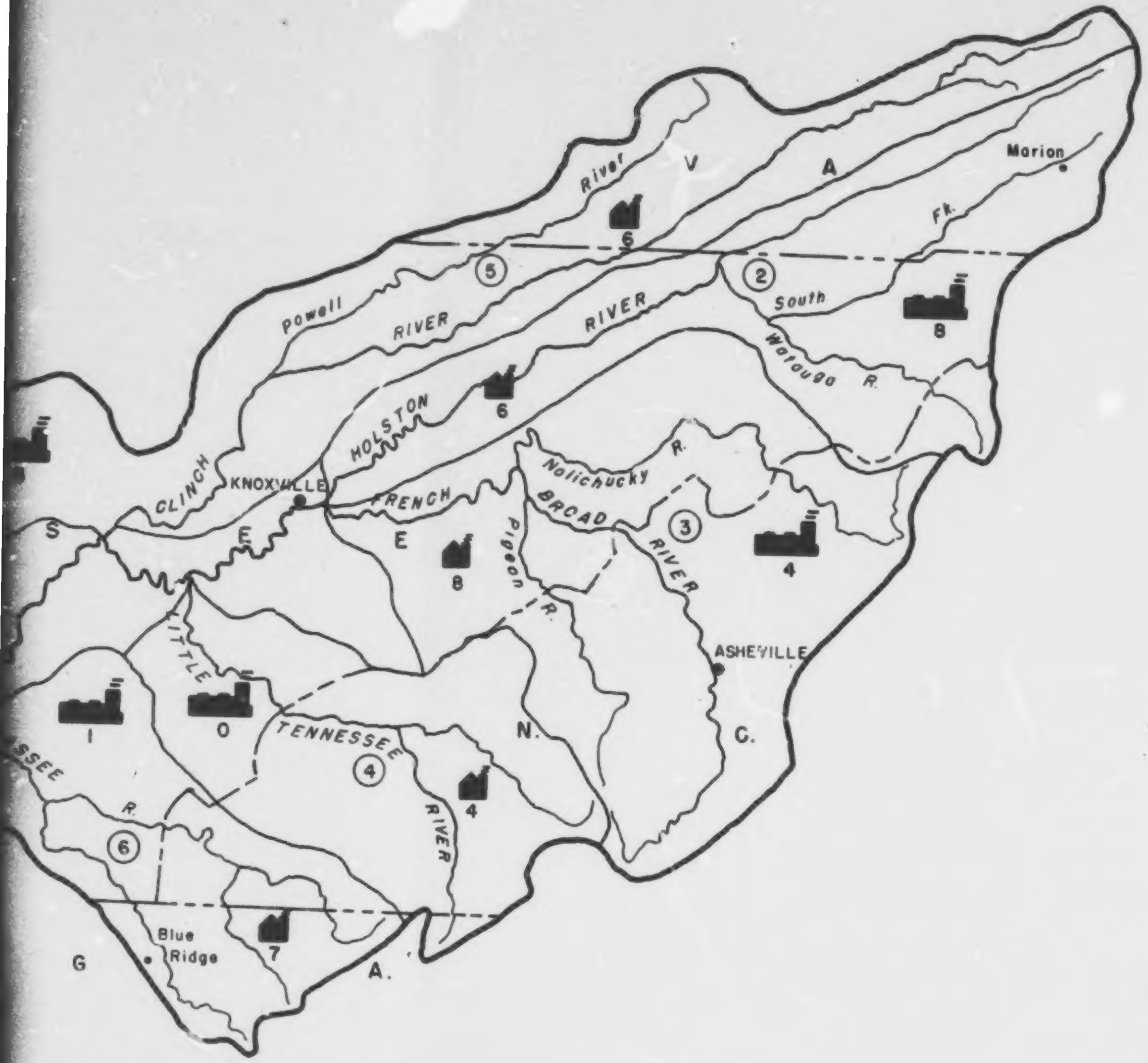
MAP NO. 2

TREATMENT WORKS

TREATMENT WORKS

SCALE OF MILES

20 10 0 10 20 30 40 50


River
V
A
Marion
Fk.
6
5
2
South
8
Powell
RIVER
RIVER
Watauga R.
HOLSTON
6
CLINCH
KNOXVILLE
FRENCH
Nolichucky R.
BROAD
3
4
S
E
E
8
Pigeon
R.
RIVER
ASHEVILLE
LITTLE
1
0
TENNESSEE
4
N.
C.
SSEE
R.
6
RIVER
4
Blue Ridge
7
G
A.

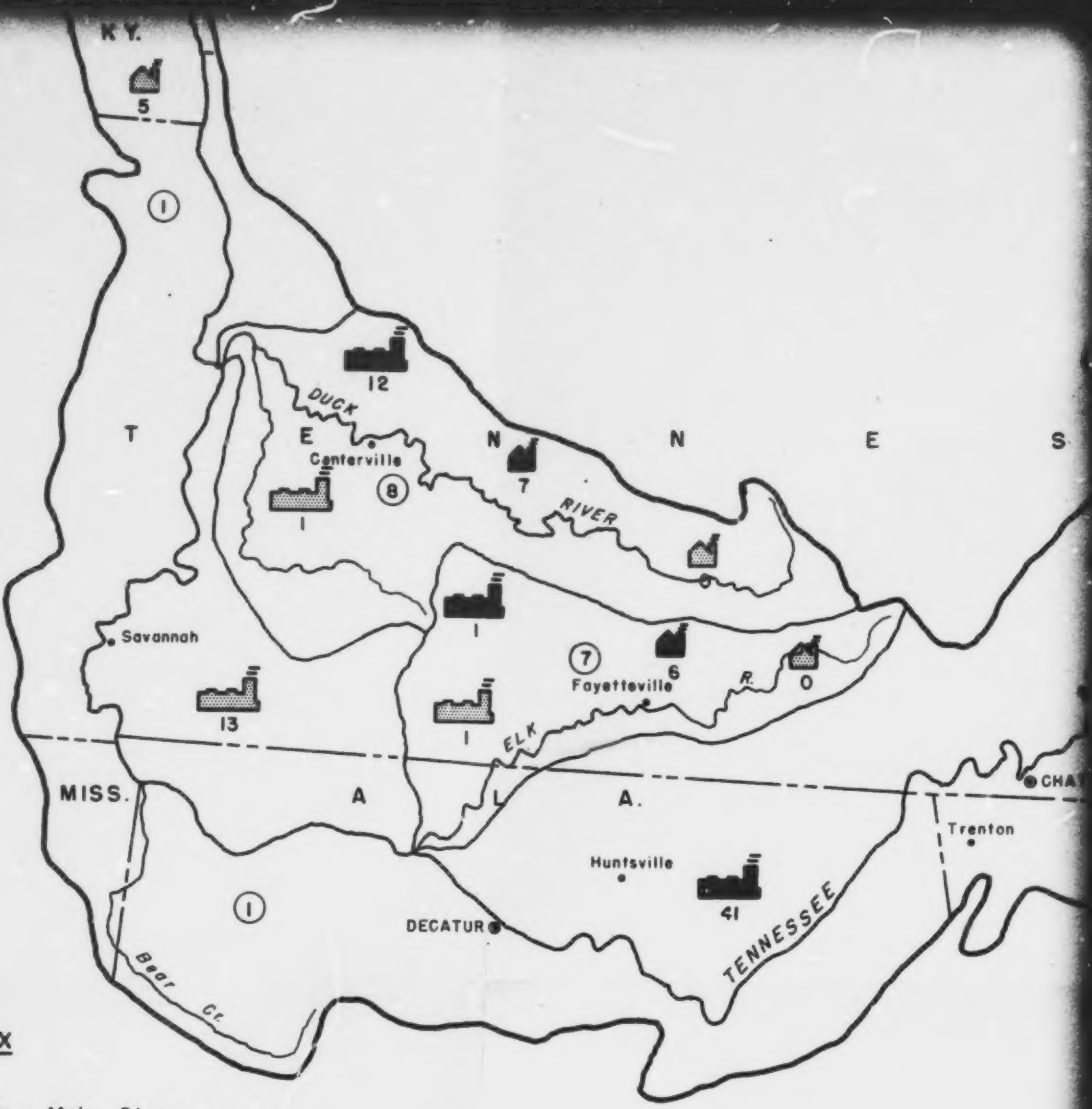
C

B

TENNESSEE RIVER DRAINAGE BASIN

EXISTING TREATMENT WORKS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL


KY.
5
①
12
DUCK
T
E
N
N
E
S
Centerville
⑧
1
7
RIVER
0
1
Savannah
⑦
6
Fayetteville
R.
0
13
1
ELK
MISS.
A
L
A.
CHA
Trenton
Huntsville
41
①
DECATUR
TENNESSEE
Bear Cr.

SUB-BASIN INDEX

① Tennessee River Basin – Main Stem
② Holston River Basin
③ French Broad River Basin
④ Little Tennessee River Basin
⑤ Clinch River Basin
⑥ Hiwassee River Basin
⑦ Elk River Basin
⑧ Duck River Basin

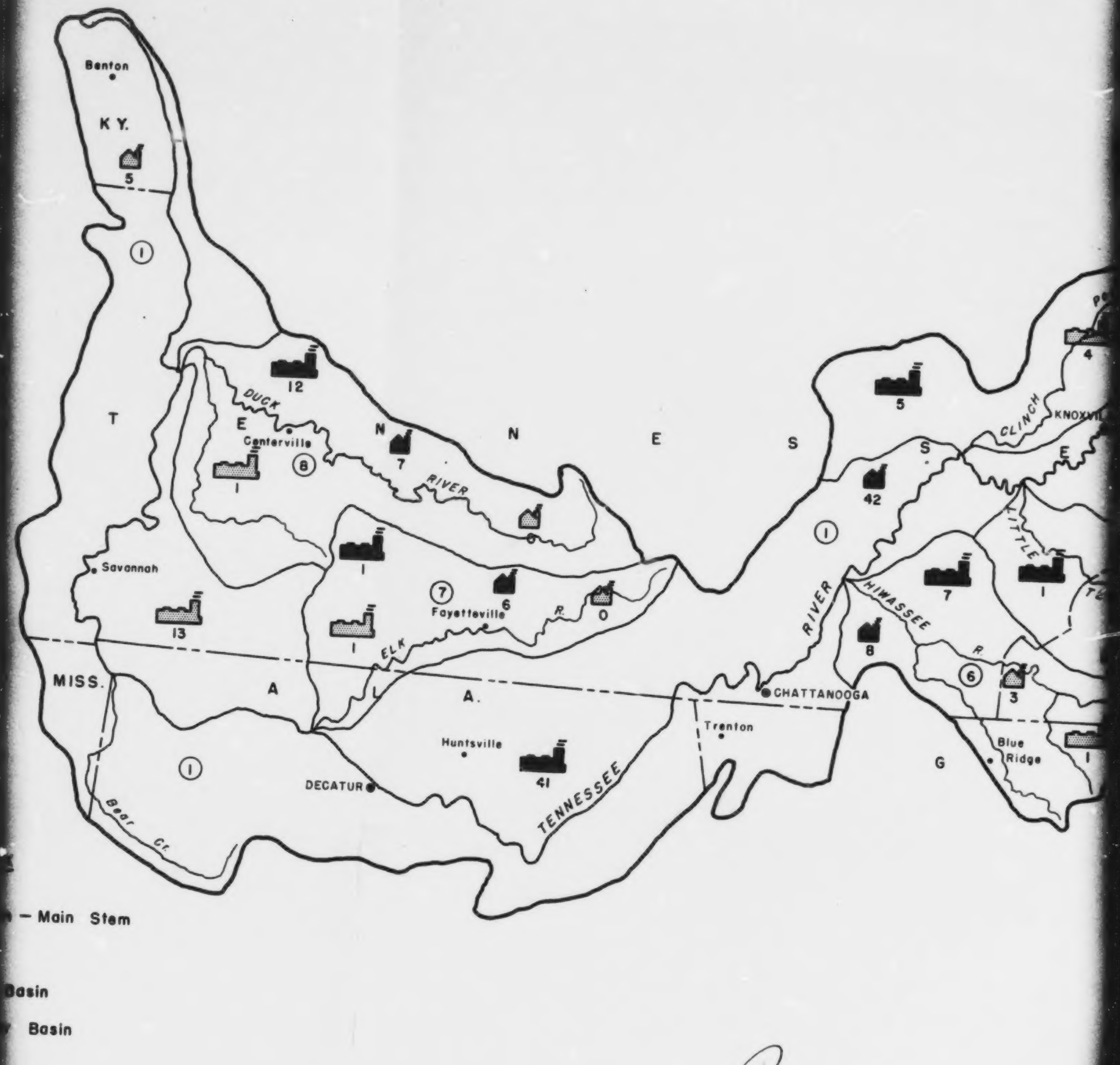
■ *NUMBER OF MUNICIPAL PROJECTS REQUIRED*

▨ *NUMBER OF MUNICIPALITIES WITH PROJECT REQUIREMENTS UNDETERMINED*

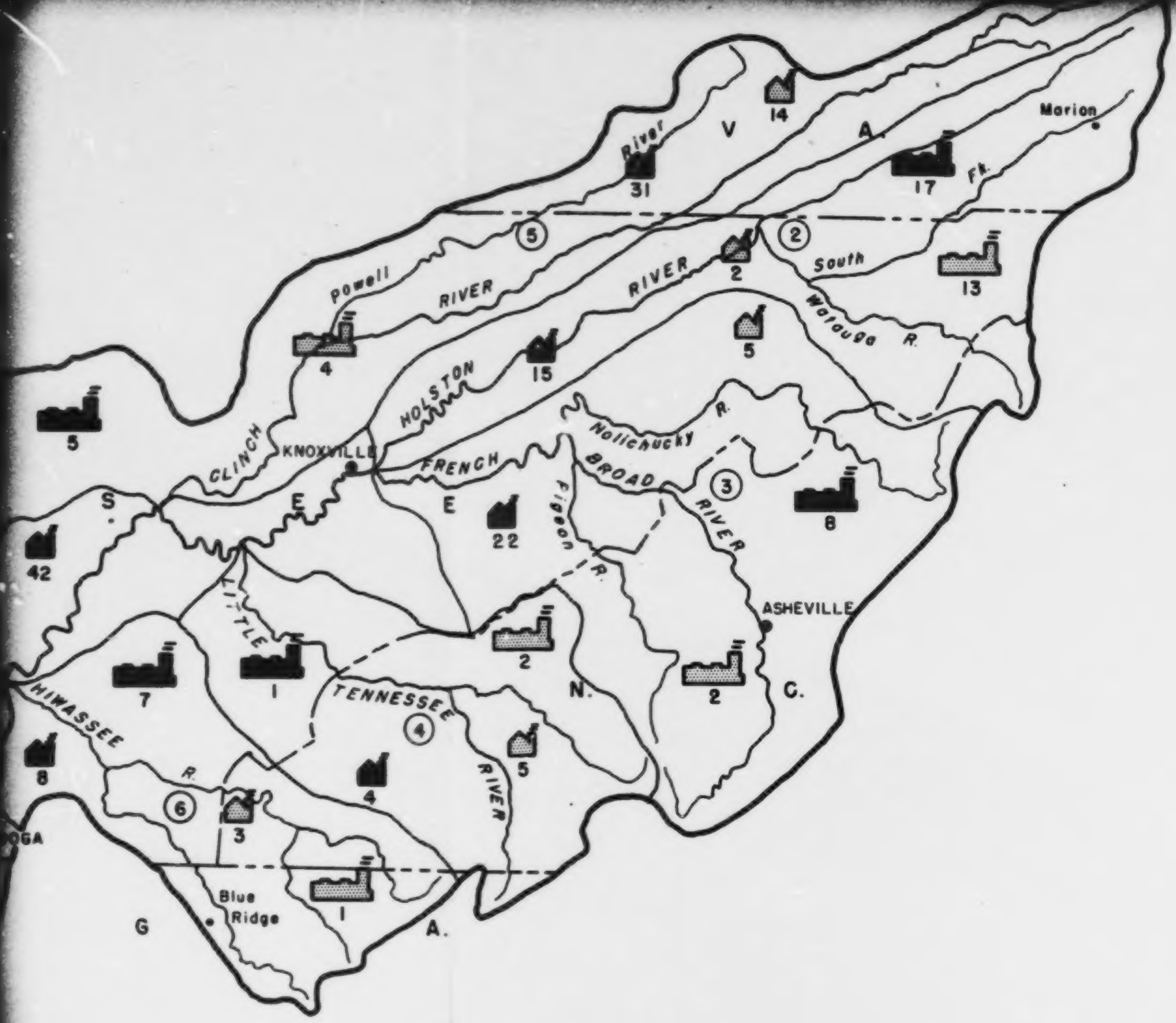
■ *NUMBER OF INDUSTRIAL PROJECTS REQUIRED*

▨ *NUMBER OF INDUSTRIES WITH PROJECT REQUIREMENTS UNDETERMINED*

A


Benton
KY.
5
1
T
12
DUCK
E
Centerville
8
1
N
7
N
E
S
RIVER
6
1
7
6
Savannah
13
Fayetteville
R.
0
1
ELK
MISS.
A
L
A.
Huntsville
41
1
DECATUR
Bear Cr.
TENNESSEE
CHATTANOOGA
Trenton
5
S.
42
1
RIVER
HIWASSEE
8
7
1
LITTLE
CLINCH
4
E
R.
6
3
G
Blue Ridge
1
– Main Stem
Basin
Basin

B


V
A.
14
Marion
River
31
17
Fk.
5
2
South
13
Powell
RIVER
RIVER
2
Watauga R.
4
HOLSTON
15
5
5
CLINCH
KNOXVILLE
Nolichucky R.
FRENCH
BROAD
3
RIVER
S.
E
E
22
Pigeon R.
8
42
ASHEVILLE
LITTLE
2
7
1
TENNESSEE
4
N.
2
C.
HIWASSEE
5
8
R.
6
4
RIVER
3
OGA
Blue Ridge
1
G
A.

C

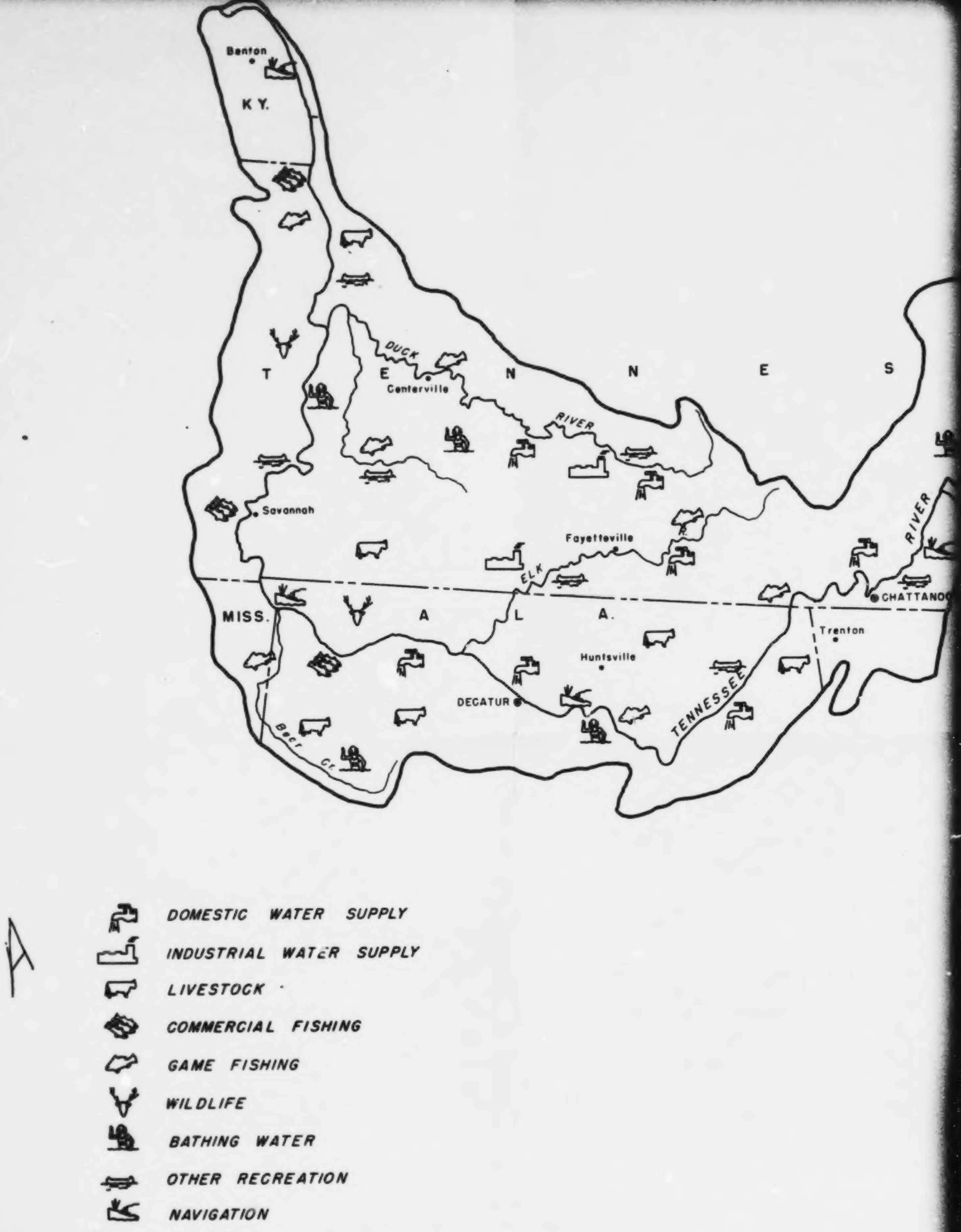
TENNESSEE RIVER DRAINAGE BASIN

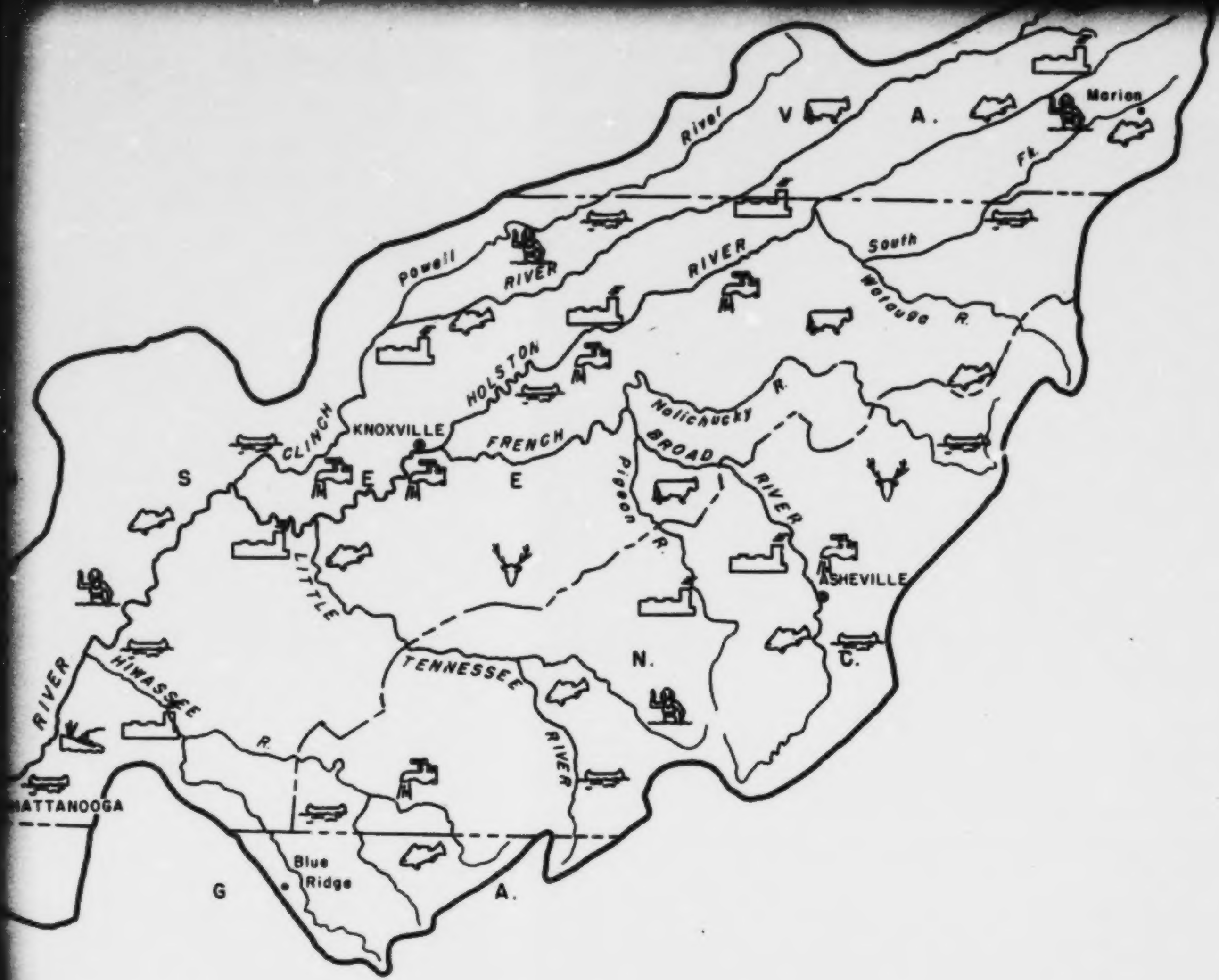
PROJECTS REQUIRED

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL

MAP NO. 3

SCALE OF MILES


Benton
KY.
T E N N E S
DUCK
RIVER
Centerville
Savannah
Fayetteville
ELK
RIVER
CHATTANOO
MISS.
A L A.
Trenton
Huntsville
DECATUR
TENNESSEE
Bear Cr.
DOMESTIC WATER SUPPLY
INDUSTRIAL WATER SUPPLY
LIVESTOCK
COMMERCIAL FISHING
GAME FISHING
WILDLIFE
BATHING WATER
OTHER RECREATION
NAVIGATION


Marion
V
A.
River
Powell
RIVER
Fk.
South
Watauga R.
RIVER
HOLSTON
CLINCH
KNOXVILLE
FRENCH
Nolichucky R.
BROAD
RIVER
Pigeon R.
S
E
E
LITTLE
ASHEVILLE
N.
C.
TENNESSEE
RIVER
HIWASSEE
R.
RIVER
HATTANOOGA
Blue Ridge
G
A.

B

TENNESSEE RIVER DRAINAGE BASIN

EXISTING PRIMARY WATER USES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL

MAP NO. 4

SCALE OF MILES
20 10 0 10 20 30 40 50

GENERAL DESCRIPTION

Historical Background

The history of the Tennessee River Basin will record the happenings which have occurred in two distinctly different river systems: one, the old river which cut its way through steep mountain ranges and broad plains to carve its place in the history of America; and the other, the new river which is now history in the making, where the total water resources of a great river system are being harnessed to better serve society. With the exception of the upper reaches, the flow characteristics of the main stem and the major tributaries have been materially changed by man-made structures and their methods of operation.

The Tennessee Valley Authority, created by Congressional Act on May 18, 1933, has been actively engaged in constructing multi-purpose control works designed primarily to lessen flood damage, to provide at least a nine-foot navigation channel throughout the 652-mile length of the main stem, and to generate hydroelectric power. The Act creating the Authority directed it to assume other broad responsibilities, including the conduct of surveys and general plans with respect to proper land use, reforestation and the development of the basin's resources for the general purpose of "fostering an orderly and proper physical, economic, and social development" of the region. Thus, the administration of the Act is more than a problem of stream management to provide flood control, navigation, and hydroelectric power; it is an historic experiment in which the total resources of a river basin are being integrated into an overall social and economic plan.

It is with this new river system and its changed characteristics that the problems of waste treatment and pollution prevention and abatement are associated.

Physical Characteristics

The Tennessee River is formed by the Holston and French Broad Rivers which join just above Knoxville, Tenn. At this point it flows southwesterly across the eastern part of Tennessee, westerly through the northern part of Alabama, then northward along the northeastern tip of Mississippi through western Tennessee and western Kentucky, a distance of 652 miles, to its confluence with the Ohio River at

Paducah, Ky.

The basin is roughly crescent in shape and includes relatively small portions of the States of Virginia, North Carolina, Georgia, Alabama, Mississippi and Kentucky and about 55 percent of the land area of Tennessee. It has a length, east to west, of about 500 miles, an average width of about 80 miles, and a total area of 40,910 square miles. The basin lies between 81° and 89° west longitude and 34° and 37° north latitude. Near Chattanooga, Tenn. the width narrows to about 45 miles, dividing the basin into two nearly equal areas.

The principal tributaries of the upstream portion are the Holston, French Broad, Clinch, Little Tennessee, and Hiwassee Rivers. The Elk and Duck Rivers are the only tributaries of significance in the lower portion.

The physiographic features differ materially in the upper and lower halves of the basin. The eastern half lies within the Great Valley and the Blue Ridge physiographic provinces. The Great Valley is a part of the Appalachian Valley, which extends southwestward across eastern Tennessee from Virginia to the Georgia line, and is characterized by long narrow parallel ridges and valleys. The region is underlain by folded and faulted limestones, sandstones and shales of the Paleozic age. Elevations vary from 900 feet at Chattanooga to over 2,000 feet in Virginia. Due to the character of the underlying formations, both the surface and underground waters are rather highly mineralized.

The Blue Ridge Region straddles the Tennessee-North Carolina boundary and is an integral part of the Appalachian Mountains with elevations varying from about 2,200 feet to over 6,500 feet. The most prominent parts are the Unaka, Iron and Smoky Mountains. This area is underlain, for the most part, by crystalline rocks with metamorphosed sedimentary rocks exposed along the western front. Because these formations are not readily dissolved, both the surface and underground waters contain a minimum of mineral constituents.

The Clinch and Holston Sub-Basins lie almost entirely within the Great Valley region, while the French Broad, Little Tennessee and Hiwassee Rivers drain both the Great Valley and the Blue Ridge regions, with the latter exerting the predominating influence on the mineral constituents. The waters of these streams are relatively low in mineral content.

Downstream from Chattanooga the watershed drains portions of the Cumberland Plateau, the Highland Plain, the Nashville Basin and the Mississippi Embayment physiographic provinces.

The Cumberland Plateau varies from 40 to 50 miles in width and stands about 1,000 feet above the Great Valley on the east and the Highland Plain on the west. Its elevation ranges from 1,500 to about 3,000 feet. The rocks of the region are of the Carboniferous age, including sandstone, shales and coal. The surface is rolling with shallow stream valleys and low ridges.

West of the Cumberland Plateau lies the Highland Plain which extends westward to the Tennessee River. The formations of the Mississippian period form the surface of the Highland Plain and consist of limestones, siliceous shales and chert underlain by the Devonian black shale. The waters vary considerably in mineral constituents, ranging from low total dissolved solids to rather high iron and sulphur contents. The region has an average elevation of about 1,000 feet. The surface is gently undulating, cut by small streams into narrow but sometimes steep-sided valleys.

In the center of the Highland Plain, erosion has cut through the Mississippian and Devonian period formations and into the softer limestones and shales of the Silurian period to form a large flat basin approximately 50 miles wide and 120 miles long, known as the Nashville Basin. This basin lies 300 to 400 feet below the encircling Highland Plain. The Duck River, flowing through deep narrow valleys, drains approximately 25 percent of this area. The waters are moderately high in dissolved solids and ground waters are generally not present in significant quantities.

The western most physiographic region of the Tennessee Basin is known as the Mississippi Embayment. This is a broad west-sloping plain extending from the western valley of the Tennessee River to and beyond the Mississippi River. Only a narrow strip, 10 to 20 miles wide, drains to the Tennessee River. It is marked by numerous small drainage divides caused by stream erosion. The underlying formation is largely unconsolidated sands, gravel, silt, and clays which form an excellent catchment basin and reservoir for underground waters. No streams of significance contribute to the Tennessee River.

Although the major tributaries of the western half of the basin, the Elk and Duck Rivers, have mineral characteristics similar to the Clinch River, the flows from these streams are not large enough to materially alter the mineral content of the main stem. Consequently, from Chattanooga to the mouth, the mineral quality of the Tennessee is quite uniform.

The upstream portion of the Tennessee Basin is rugged and mountainous and generally wooded, except in the main valley. It is characterized by swift flowing mountain streams passing through narrow and steep mountain valleys. The streams were originally clear-flowing, but uncontrolled clearing of steep slopes has resulted in considerable eroded silt being deposited in the streams during storm run-off. The downstream portion of the basin is composed of plateaus and rolling plains which are devoted to agricultural pursuits. The streams take a more meandering course through broader flood plains and carry considerable turbidity a major portion of the time.

Climate-Hydrology

The annual rainfall in the basin is relatively heavy and the seasonal and annual distribution is highly irregular. The average rainfall for the basin is about 52 inches, varying from a minimum of slightly less than 40 inches to a maximum approximating 85 inches. The minimum precipitation occurs during the fall months, with maximums occurring during the winter. Precipitation variations in general follow the variations in altitude, which also effect temperatures, resulting in pleasant summer temperatures in the southeastern portion of the basin - a popular summer resort area. Temperatures are moderate and fairly uniform with an annual mean approaching 59° F.

Stream flows and run-off are both variable and irregular with great variations existing between average annual and minimum flow. Run-off averages approximately 24 inches for the entire basin, varying from a low of 14 inches to a maximum of 34 inches with even greater fluctuations on some small watersheds. Most of the run-off occurs from December to May inclusive. The stream management program of the Tennessee Valley Authority has materially reduced flow variations on those stream stretches below their reservoirs.

Economic Development

The basin is rich in natural resources, not the least of which are its surface waters and related water power development. Coal, asphalt, clay, sand, gravel, limestone, phosphate rock, iron, zinc and copper constitute the principal subterranean resources, while the surface supports large growths of hard and soft woods and diversified agricultural crops, including corn, cotton, tobacco, forage crops and vegetables.

In many places unwise clearing, pasturing, and tillage practices have caused serious loss of the richer top soils by water erosion. The situation is further aggravated because the heaviest rainfall occurs during the winter months when the vegetation affords little ground cover.

In general, ground water aquifers are limited in their yield and can not be expected to supply the water needs of large centers of population or large water consuming industries. Surface waters, which are plentiful, must be relied upon to supply such requirements.

Another important resource of the basin is the natural and man-made recreational areas which are now being patronized by many thousands of people annually.

The population of the Tennessee Basin was about 2,500,000 in 1940 of which 75 percent was rural. There are few large centers of population, and despite the rugged terrain of the eastern portion, the population distribution is remarkably even. Only two cities have populations exceeding 100,000, while less than thirty cities in the basin have populations exceeding 5,000. The basin has enjoyed a slow but continuous population increase for the past century, with considerable growth taking place during the past two decades.

Although the region is predominately rural, almost every type of industry can be found, many dating back to pre-civil war days. The basin has long been one of the few remaining hardwood producers of the Nation and national markets are supplied with hardwood products. Textile manufacture is the most important industry in the basin, while chemical, pulp and paper, tanning, meat, milk, and vegetable processing constitute other important and significant industries.

Industrial development received considerable impetus with the creation of the Tennessee Valley Authority in 1933. The regulation of the stream system for navigation and flood control and the development of hydroelectric power, together with relatively untouched sources of labor and raw materials, offered considerable economic advantages to many industries. As a result, there has been a rapid industrial growth throughout the basin during the past ten years.

Because of National defense requirements in the early nineteen-forties, considerable stimulus was provided for the early completion of the major water development program of the TVA. Nine multi-purpose dams on the main stem of the Tennessee River create a continuous series of reservoirs from its mouth at Paducah, Ky. to its source at Knoxville, Tenn. Reservoirs have also been constructed or acquired on the Clinch, Holston, French Broad, Little Tennessee, Hiwassee, Ocoee, Elk and Duck Rivers. These reservoirs make it possible to provide for stream flow regulation not now found on any other large stream system in the Nation. Their creation has been responsible for a rapid increase in the development of recreational facilities at nearly all reservoir sites. Both game and commercial fishing are on the increase. If the water quality of the basin streams and lakes is maintained in a condition compatible with recreational uses, the recreational industry may well become the most valuable resource in the region.

USES OF WATER RESOURCES

Water uses in the Tennessee Basin are extensive and varied. They include public and industrial water supply, navigation, hydroelectric power, recreation, fish and wildlife propagation, livestock watering and final waste disposal.

There are 262 public water supplies in the basin serving a population of 850,000, in addition to a large number of industries. Approximately one third of these supplies, serving a population in excess of 650,000, obtain their sources from surface waters. It is significant that only 8 cities having populations exceeding 5,000 obtain their supply from ground water sources alone. Thus, it is quite apparent that the surface waters of the basin must be depended upon to furnish the water supply for an increasing number of municipalities. If this highest water use priority is to be preserved, pollution abatement on a broad scale must be accomplished and new sources of pollution must be prevented.

Industrial water needs in the basin exceed those for domestic purposes. While much of the water used by industry is for cooling purposes, considerable quantities are required in manufacturing processes, many of which require an extremely high water quality. In some instances the raw water quality requirements for industrial use are more rigid than for domestic use. Pollution has already seriously degraded many surface waters in the region, valuable as industrial water supplies.

As previously stated, recreation-- including boating, bathing and fishing-- is rapidly becoming big business throughout the basin. The twenty-seven major reservoirs, plus many miles of mountain streams and pools behind minor storage dams, offer ideal recreational facilities provided those waters are of a quality to support such uses. Already several reservoirs and many miles of streams are polluted to the extent that bathing cannot be condoned because of public health dangers, and desirable fish and aquatic life have been destroyed.

Navigation and hydroelectric power are well developed and play an important part in the economy of the basin and the Nation. The main stem from Knoxville, Tenn. to the confluence with the Ohio River is now navigable, and during 1949 over 500,000,000 ton miles of water freight was transported (Data from U.S. Army Engineers). The installed generating capacity for hydroelectric power was 2,402,560 KW as of January 1, 1950.

Not the least in importance is the use of surface waters for final waste disposal. It is recognized that the water courses must be used for final disposal of domestic and industrial wastes. However, in the Tennessee Basin as elsewhere, the assimilative capacities of many streams have been so overtaxed that they can no longer supply the needs of other water uses. The proper development of the stream system is dependent on reasonable use of the waters for waste disposal.

The creation of a series of reservoirs and the control of water releases from such reservoirs for navigation, flood control and power generation has a profound impact on pollution control problems in the basin. Reservoir releases may have either adverse or beneficial effects according to the available quantity of water for dilution. The biological, physical, and chemical characteristics of the waters in the reservoirs are materially altered from those common to free flowing streams. Such changes may also exert both adverse and beneficial effects on the streams ability to assimilate pollution. Unfortunately, the act creating the Tennessee Valley Authority did not include pollution control among the other desirable water uses. The potential economic value of sustained minimum flows for pollution control is well recognized. The full benefits of a comprehensive water use program may not be realized unless the water resources are made available for pollution control. This factor is recognized throughout the basin and further study is needed on integrating water uses for pollution control in the management policies of the Authority. Considerable study is likewise required on the changed biological,physical, and chemical characteristics of the streams and reservoirs, insofar as they effect the maximum utilization of these waters for pollution control.

POLLUTION CONTRIBUTED TO WATER RESOURCES

For the purpose of reporting sources and quantities of pollution in the Tennessee River Basin, the area has been divided into eight major watersheds including: (1) Main Stem of the Tennessee River and Minor Tributaries, (2) Holston, (3) French Broad, (4) Little Tennessee, (5) Clinch, (6) Hiwassee, (7) Elk, and (8) Duck Sub-Basins. Data pertaining to the individual sub-basins are found in "Part II - Sub-Basin Reports." The data contained in this part of the report relate to the Tennessee Drainage Basin as a whole.

Table A indicates there are 201 centers of population, including municipalities, sanitary districts, institutions and resorts, contributing significant amounts of pollution to the basin. A total population of 797,126 is served by sewerage systems at 198 of these sources of pollution. The population served at the other three sources is undetermined. The waste load discharged to the streams from 185 sources, in terms of population equivalent, is 1,069,445. The waste load discharged from 16 sources is undetermined.

Data are not available to indicate the population equivalent of the wastes discharged to all of these 201 sewerage systems. Consequently it is impossible to determine just how much has been removed by treatment facilities. This is discussed in more detail under "Pollution Prevention Measures in Effect."

Table B indicates there are 148 industries, with separate outlets, contributing significant amounts of pollution to the basin. Eighty-seven of this number contribute organic wastes having a population equivalent of 1,412,700, or slightly greater than that discharged through municipal outfalls. This does not represent the total industrial waste load however, as industrial wastes discharged to municipal sewer systems constitute more than one third of the total organic load from those sources. The major industrial contributors of organic wastes are the pulp and paper, chemical, and textile industries. Tanning, meat packing, canning and milk processing plants contribute lesser but significant amounts. In addition to the 87 industries contributing known amounts of organic wastes, 15 other sources contribute organic wastes, the population equivalent of which have not been determined.

There are 61 industrial outfalls discharging inorganic wastes of various types, all of which damage other water uses. These include acid wastes from coal mines and steel plants, toxic metal wastes from metal processing plants, phenolic and other taste and odor producing wastes from coke plants and chemical plants, brines and sulphates from chemical plants, silt from mining operations and soil erosion, and color producing substances from textile and paper and pulp industries. The significance of wastes from the coal industry is not represented by the tabular data, since complete data have not been obtained for either active or abandoned coal mines. It has been estimated that, as of 1940, 22,000 tons of acid mine drainage were discharged to the streams each year.

Tables A and B show that the total organic waste load discharged to the basin, from sources where data on waste load are available, is equivalent to that coming from 2,482,000 people. In other words, the streams are being used to dispose of pollution having an equivalent population essentially equal to the total population of the basin. Comparing this figure with "Population Served by Sewerage System" in Table A, it is evident that the industrial pollution is slightly more than twice that of domestic sewage.

The major pollution load originates in the upper portion of the basin above Chattanooga, Tenn. On the main stem of the Tennessee River, the largest concentrations of both domestic and industrial wastes are found around Chattanooga and Knoxville, Tenn. The pollution discharged to this sub-basin represents 38 percent of the total load. The Holston River received a greater pollution load than any other major tributary -- 26 percent of the total-- followed by the French Broad and Clinch River Sub-Basins in the order named, with 51 percent of the total pollution in the entire basin emptying into these three river systems. Seventy-five percent of this organic pollution comes from industrial outfalls, the principal contributor being pulp and paper, chemical and tanning industries.

The Little Tennessee, Hiwassee, Elk and Duck River Sub-Basins receive relatively small amounts of pollution, the entire amount representing only slightly over 10 percent of the total for the basin.

It is significant to note that the industrial pollution problem in the basin is one of long standing. As long ago as 1905, L. C. Glenn, in writing about the Great Valley physiographic region in Tennessee, in "Water Supply and Irrigation Paper No. 114," United States Geological Survey, 1905, stated, "Although the valley is well settled, the population is largely agricultural and scattered, and the stream supplies may be regarded as safe except where contaminated by tan bark, wood pulp, or other similar industries." The streams of the basin have continued to receive increasing amounts of both domestic and industrial pollution since that time.

The Tennessee River Basin was included in a comprehensive stream pollution survey of the Ohio River and its tributaries, conducted by the Public Health Service and Army Engineers from 1939 to 1941. The report of this survey was published as H. Doc. 266, 78th Cong., 1st. sess. The field data for the Tennessee River were completed in February 1941, and the comparison of these data with existing information indicates that the known organic pollution load has increased over 35 percent during the past decade, despite the fact that several heavy contributors of industrial wastes ten years ago have since materially reduced their pollution load to the streams.

It is also important to note that the more heavily polluted streams, the Holston, French Broad, Clinch, and Tennessee Rivers, are all interstate waters. In all instances, pollution arising in one State is affecting the legitimate water uses in an adjoining State.

Table A - Sources of pollution - Municipal

Municipalities*	Sources of pollution (In number of* municipalities)#	Population served by sewerage system	Amount of pollution discharged to water-course (In terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	185	785,405	1,069,445
Having population data available (Data on pollution load to water-course incomplete or not available)	16(.)***	11,721***	Not applicable.
Total	201(.)***	797,126***	---

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers.

** Includes industrial wastes discharged into municipal sewerage systems.

# Includes several sanitary districts (serving an undetermined number of municipalities and other political subdivisions), each of which is listed as one source of pollution.

(.) Includes 2 municipalities for which no data on population served are available. Also includes Oak Ridge, Tenn., for which no municipal or industrial waste data or treatment data are available.

*** Includes 5 communities having no comprehensive sewerage system. These communities have an estimated combined population of 1,339.

Table B - Sources of pollution - Industrial*

Industries	Sources of pollution (In number of plants)	Amount of pollution discharged to watercourse (In terms of equivalent number of people)
Producing organic wastes	87**	1, 412, 730
Producing organic wastes	15(.)	Undetermined.
Producing inorganic wastes	61	Not applicable.
Producing wastes of undetermined type	3	Undetermined.
Total	148#	---

* Industries having separate outlets and discharging wastes directly to watercourse.

** Includes 16 plants also producing inorganic wastes.

(.) Includes 2 plants also producing inorganic wastes.

# Total adjusted to correct for duplication noted in footnotes marked thus, ** and thus (.).

DAMAGES TO WATER RESOURCES FROM POLLUTION

Despite the abundance of surface waters in the Tennessee River Basin, serious damages to water uses have resulted from the uncontrolled discharge of domestic and industrial pollution. The discharge of domestic sewage has resulted in bacterial pollution of such magnitude as to make many miles of streams unfit for domestic water supply sources and for recreational purposes. However, industrial pollution is probably of even greater significance from the standpoint of those water uses not directly associated with public health.

On the North Fork of the Holston River, chemical plant wastes contribute excessive amounts of hardness, chlorides and sulphates to the receiving waters. Hardness values of the stream average over 600 parts per million, with maximum values in excess of 2, 500 parts per million. These detrimental effects are reflected in an increase in the hardness and resultant increase in cost to the consumer in the public water supply of Knoxville, Tenn., below the mouth of the Holston River. Such waters are also unsuitable for many industrial water uses. Color from the French Broad and Pigeon Rivers also adds to the water treatment costs at Knoxville, where increased chemical dosages are required for reducing this pollutant to acceptable limits.

Silt, from mining and ore processing operations, discharged to the Nolichucky River, a major tributary of the French Broad, has seriously damaged fish life in this stream.

Pulp and paper mill wastes emptying into the upper reaches of the French Broad, Pigeon, and Tuckasegee Rivers add both oxygen depleting substances and color to these streams, the effects of which are felt throughout the downstream reaches. Newport, Tenn., located on the Pigeon River near its confluence with the French Broad, is badly in need of additional water to supplement inadequate ground water resources. Despite the fact that these two large streams flow by its doorstep, pollution makes their use unfeasible. Color and organic pollution have also discouraged consideration of these waters for industrial use.

Although the water treatment plant for Knoxville, Tenn., is located below the junction of the Holston and French Broad Rivers, color from the latter stream directly affects and adds to the water treatment problems and costs.

During low stream flows paper mill wastes in the Emory River at Harriman, Tenn. have adversely affected the public water supply of that city.

Silt pollution from phosphate plants on the Duck River are reported to have damaged fish life in this stream.

Domestic and industrial pollution from the Knoxville and Chattanooga, Tenn. areas have damaged other water uses on the main stem of the Tennessee River. For over 40 miles below Knoxville the stream is not suitable for use as a public water supply, nor is it unsuitable for recreational use. Consequently, the potential recreational resources of much of the Fort Loudoun Reservoir cannot be realized until the pollution is reduced. Below Chattanooga the domestic and industrial pollution is so great that the main river is unfit for certain kinds of fishing, and for recreational use in general. The use of the water for public and industrial water supplies is also jeopardized. The effects of this source of pollution extend well into Guntersville Reservoir.

Throughout the basin untreated wastes have reduced many receiving waters to little more than open sewers, especially during periods of minimum stream flows. Such stream conditions are local in effect, but those stream stretches have lost all value for any legitimate water use and will remain so until corrective action is taken. Some States report numerous complaints from such areas that the water is unfit for livestock watering and, of course, such waters are uninhabitable from the standpoint of fish life.

Acid mine drainage from coal mining operations has increased the acidity in some local areas in the Cumberland Plateau region, but so far the problem is local in extent and is largely one of prevention rather than abatement.

Although the tangible monetary damages from pollution are considerable, the intangibles are probably even more significant. Damages to public health, the general welfare and well-being of the population are difficult to evaluate. However, such damages can become more costly than some of those subject to computation, such as the cost of chemicals to remove hardness added to the stream by industrial wastes.

Health is worth what it costs, and enjoyable living and working conditions are sought after by all.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

Pollution abatement and control must become an integral part of the total water use program in the Tennessee River Basin. Reduction of existing pollution will restore the waters to a usable condition for other water uses. Prevention of new pollution will preserve the now usable waters for future needs and will hold the advantages gained by corrective action.

Public water treatment plants now treating grossly polluted waters, can be operated with greater factors of safety from a public health standpoint, and at less cost if existing pollution is reduced. Surface waters, now unfit for either public or industrial water supplies, will then support the needs of expanding and new industries and accompanying population increases. Many hundreds of miles of stream and lake-shore lines, now unusable, will be reclaimed to provide recreational facilities unexcelled any place in the Nation. Fish life will again be restored to many miles of "has been" streams and will be enhanced in many newly created lakes. Prevention of stream and lake siltation, now harmful to fish and aquatic life and which is reducing effective reservoir capacities, will serve an even more important function - the conservation of top soil for productive purposes. Damages to power and navigation structures and equipment from corrosive pollutants will be reduced.

Although tangible monetary benefits resulting from pollution control may be assessed to practically all legitimate water uses, intangible benefits are no doubt of equal or greater value.

The beauty of a clear mountain stream, the enjoyment of swimming, fishing, and boating in nearby streams, the value of a drink of sparkling and palatable water, and the value of living in an environment free from unsightly and malodorous streams cannot be measured by the dollar sign. However, it is a well established fact that millions of Americans annually spend more millions of dollars to enjoy such pleasures for only a few days of the year. Certainly, some monetary value must exist.

POLLUTION PREVENTION MEASURES IN EFFECT

Table C shows the number of sewage treatment facilities in the basin and the population served. From these data it is determined that 28 percent of the 200 municipal sources of pollution, exclusive of Oak Ridge, for which no data are available, have primary treatment only, while 10.5 percent have secondary treatment. Thus 61 percent of the municipalities having sewer systems discharge untreated sewage into the streams of the basin. On a population basis the picture is even worse, as the waste from 90 percent of the population served by municipal sewer systems receives no treatment, while 12 percent of the population is tributary to primary treatment facilities and only 8 percent tributary to secondary treatment facilities.

On the basis of average performance of primary and secondary sewage treatment units, it is estimated that the existing municipal sewage treatment plants remove only about 80,000 equivalent population. This, in effect would reduce the total pollution load contributed by municipal outfalls by approximately 10 percent and only by about 3 percent on the basis of the total organic wastes from both municipal and industrial sources. From the data contained in Table E, however, it would appear that at least 50 percent of the existing treatment plants are overloaded. Consequently, treatment plant efficiencies are no doubt below average, resulting in still lesser effects on the overall pollution abatement picture. Also, in some instances, existing treatment plants are considered satisfactory for present loads, but enlargements or additions are indicated in order to meet expanding demands forseeable at this time.

Table D classifies the industrial sources of pollution according to type of industry and shows the status of treatment facilities for such industries. These data show that food, textile and chemical industries are about equally distributed in numbers of plants, and together they account for 101 of the 148 industrial sources of pollution having separate outlets and discharging directly to watercourses. These 101 industries, together with the seven pulp and paper plants and the seven leather and leather products plants, contribute the major portion of the total organic wastes discharged through industrial outfalls. Thirty-nine, or 26 percent of the industries listed have some type of waste treatment facilities and all but two of those facilities are situated at one or another of the industries above named.

However, in terms of adequacy of treatment facilities (Table E), it appears that approximately 50 percent of those facilities on which information is available are inadequate from a capacity standpoint. Although not shown in these tables, it should be pointed out that of the 39 industrial waste treatment plants noted in Table D, twenty-two are at industries producing inorganic wastes. Furthermore, of the thirteen satisfactory waste treatment plants shown in Table E, only two are treating organic wastes. Thus it is apparent that a very small portion of the total organic industrial waste in the basin is receiving satisfactory treatment.

The efficiency of treatment plants is greatly influenced by the quality of operation. Good operation of an inadequate and overloaded plant may often result in a better effluent than that discharged from one having adequate physical facilities but which is poorly operated. Table E indicates that the quality of operation more nearly meets accepted standards than do the plant capacities.

Table F shows the municipal and industrial waste treatment facilities which have been placed in operation since World War II. It will be noted that comparatively little construction of abatement works has been undertaken during the postwar period in the Tennessee River Basin. However, some progress has been made, especially in connection with industrial wastes. One large pulp and paper industry has greatly reduced pollution load to the stream by plant process changes, while another has taken temporary steps to reduce the effects of their pollution during low flow periods, on a stream serving a public water supply. Several industries are active in research and pilot plant studies on wastes for which there is now no known practical treatment process. The fact remains, however, that the construction of sewage and industrial waste treatment plants has not kept pace with the population growth and industrial expansion in the basin. Moreover, the increasing industrial growth in the basin, which is being stimulated by development of the natural resources, accentuates the need to expedite the installation of waste treatment facilities.

Analysis of State Water Pollution Control Legislation

The following analysis presents briefly the salient facts regarding water pollution control legislation of the various States in the Tennessee River Basin. It is based on previous analyses of State legislation which were reviewed by the various States and used in the development of a suggested State water pollution control act which was subsequently endorsed by the Council of State Governments and recommended to the States for favorable consideration.

Four of the seven States in the Tennessee Basin - Alabama, Kentucky, Virginia and Tennessee - have established boards or commissions which have general water pollution abatement, prevention and control powers and duties. In all seven States, the respective health departments have water pollution control functions, although in Mississippi authority is divided between the State Board of Health and the Game and Fish Commission. Six States have specific legislation dealing with the administrative handling of water pollution control. In Georgia water pollution control authority is exercised within the framework of the State Board of Health's general supervision of all matters relating to the "life and health of the people."

In States which have a specific board or agency for water pollution control, Alabama, Kentucky, North Carolina and Tennessee have the mixed type composed of ex-officio members representing State government and members representing affected interests; Virginia provides for members to be appointed by the Governor on the basis of merit.

Three States - Kentucky, Tennessee and Virginia - provide by statute for an executive officer to be in charge of the water pollution control program.

Alabama and Kentucky have given their water pollution control authorities specific statutory duty of developing comprehensive water pollution control programs for those States. In Alabama, Kentucky, Mississippi (Game and Fish Commission), North Carolina, Tennessee and Virginia, the water pollution control authorities have the power to establish water quality standards, and in Alabama the water pollution control authorities, in addition, have the specific statutory duty to classify waters.

By statute, Alabama, Kentucky, Tennessee and Virginia require permits, after examination of plans and specifications, for the construction of new sewage systems and treatment works and extentions thereof. In addition, Kentucky requires permits for extensions, modifications, or additions to factories, manufacturing establishments or business enterprises the operation of which would cause an increase in the pollution load of any waters of the State. In Mississippi, plants discharging industrial wastes are required to procure permits from the Game and Fish Commission. In North Carolina, only State institutions and towns are required to procure permits prior to construction of sewage systems and treatment works and extensions thereof.

All the States in the Basin are authorized to issue rules and regulations relating to water pollution control. Only the Mississippi Game and Fish Commission is required to hold hearings before such issuance.

In Alabama, Kentucky, Mississippi (Game and Fish Commission) and Virginia, the water pollution control authorities are specifically authorized by statute to issue, after hearings, orders relating to pollution abatement and control. In Tennessee, enforcement powers are suspended pending the report of the Stream Control Commission which is charged with recommending a specific program of pollution control during the 5-year period ending June 30, 1956.

Alabama, Kentucky, Mississippi (Game and Fish Commission) Tennessee and Virginia have specific statutory authority to hold administrative hearings and to issue subpoenas and administer oaths in connection therewith.

Kentucky and Tennessee do not provide for any exceptions from their water pollution control statutes. In Alabama "industrial streams" (including some specifically designated by statute) are exempted from the water pollution control statutes. The Alabama statutes further provide that the correction of existing pollution not creating a health hazard is subject to legislative approval. Georgia provides that industrial wastes are exempted from the State statute prohibiting polluting waters and killing fish. In Mississippi the Game and Fish Commission does not have any authority relating to pollution control over the Mississippi River, non-navigable waters or waters which are land-locked and privately owned. Municipalities of that State emptying fecal sewage into waters in 1946 are now subject only to "reasonable regulations" of the Game and Fish Commission, and municipalities which empty sewage into creeks 25 miles long are subject only to health control. In North Carolina the statute which prohibits pollution detrimental to fish exempts corporations chartered before March 4, 1915, and also exempts dyes and sewage from cotton mills. In Virginia certain sanitation districts are exempt from State water pollution control except for special orders of the State Board.

Table C - Existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	57	56	100, 577
Secondary	21#	22	64, 245
No treatment	122** #	---	632, 304**

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers.

** Includes 5 communities having no comprehensive public sewerage system, but for which population data are available. These 5 communities have an estimated combined population of 1, 339.

# Includes 1 municipality for which no population estimates are given.

The above table excludes Oak Ridge, Tenn., for which no domestic or industrial waste data or treatment data are available.

Table D - Existing treatment facilities - Industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products	36	9	27	0
Textile mill products	32	0	32	0
Lumber and wood products	1	0	1	0
Paper and allied products	7	3	4	0
Chemical and allied products	33	23	9	1
Products of petroleum and coal	3	0	3	0
Leather and leather products	7	2	5	0
Primary metal industries	3	0	2	1
Fabricated metal products	5	0	5	0
Coal mining**	1	0	1	0
Coal washing	1	0	1	0
Zinc mining	1	0	1	0
Other mining industries	1	1	0	0
Miscellaneous	14	1	12	1
Undetermined	3	0	3	0
Total	148	39	106	3

* Industries having separate outlets and discharging wastes directly to watercourse.

** This one mine does not represent the extent of the coal mining industry in the basin. Generally, active coal mines and abandoned mines contributing acid mine drainage have not been reported.

Table E - Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satis-factory	Unsatis-factory	Unde-termined	Satis-factory	Unsatis-factory	Unde-termined
Municipal	78	32	34	12	57	6	15
Industrial	39	13*	13	13	21	4	14

* Table G shows 19 industrial plants as requiring no project, while Table E shows 13 having satisfactory treatment. Of the 6 industries not included under satisfactory design, 2 can be corrected by operating changes, 2 have no treatment but do not require treatment at present, 1 is included in Table E under Undetermined, and 1 is unsatisfactory but not serious enough to require changes.

Table F - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (In terms of equivalent number of people)
1946	0	---	1*	2,400
1947	0	---	1*	1,500
1948	1	1,000	5*#	17,400
1949	1	11,630	3	87,300

* In addition, between 1946 and 1948 one plant in North Carolina, in the French Broad River Sub-Basin, reduced waste discharge from equivalent population of 216,000 to 65,500 by revisions in plant processes and one other plant in the same sub-basin at Enka, N. C. has made substantial reduction in waste discharged. # Includes 2 plants which discharge wastes having no B. O. D.

POLLUTION PREVENTION MEASURES REQUIRED

Table G lists the waste treatment requirements as determined by the State water pollution control agencies in the basin. Of the 201 municipal sources of pollution only 32, or 15 percent of the total number, now have adequate treatment facilities. From a population standpoint, less than 8 percent of the population tributary to municipal sewerage systems is provided with adequate sewage treatment facilities. Eighty-five percent of the population served by sewers requires new plants or replacement of existing plants. Although the treatment requirements at 34 municipalities are unknown, these communities are all small and represent less than 4 percent of the total population served. Therefore, they are of minor significance in the over-all pollution abatement program.

At least 55 percent of the industrial sources of pollution require entirely new treatment facilities, while only 14 percent of those contributing pollution now are providing adequate treatment. In this connection it should again be pointed out that most of these facilities now considered adequate are treating inorganic chemical wastes and have very little effect in reducing the industrial organic pollution load in the basin.

The construction program necessary to carry out the required pollution abatement program may not result in the building of the exact number of treatment plants indicated in Table G. Some adjoining political subdivisions now discharging wastes separately, may form sanitary districts and treat these wastes at one plant, while some industries will no doubt enter into agreements with municipalities to treat the industrial wastes with municipal sewage. The data do indicate the sources of pollution requiring treatment and show the general lack of adequate treatment facilities throughout the basin.

Table H indicates the status of treatment works projects required to abate pollution. Definite corrective measures have been initiated for approximately 25 percent of the total number of municipal sources of pollution at which new or additional treatment is required. These measures include preparation or completion of final plans, projects which have proceeded to the point where construction awaits solution of financial problems, and projects under construction. From the standpoint of the total pollution load, the status of pollution abatement projects is more favorable than indicated by a comparison of projects based on number of sources. While no formal action has been taken for 77 municipal sources of pollution and the status of 49 has not been determined, these sources contribute less than 50 percent of the total pollution load. In addition, a small number of these municipalities have treatment, the adequacy of which has not been determined. Definite corrective measures have been initiated for more than half of the pollution load contributed to the streams. This progress is more significant when it is realized that practically all of it has taken place in the postwar period. Further progress, not reflected in Table H, has been accomplished through informal action and educational programs of the respective State pollution control agencies. The tabular data indicate that no formal action has been taken at half of the industrial sources of pollution requiring treatment and that the status of 17 percent is undetermined. Table H lists 25 industrial installations as awaiting financing. These industries have made definite plans to connect to municipal sewerage systems where plans for treatment have proceeded to the financing stage. Substantial progress is being accomplished at some of the major industrial sources of pollution, through the cooperative efforts of State and industrial personnel, by reduction in waste through changes in plant processes and operating methods.

An effective basin-wide water pollution abatement program will require effective State legislation. Several of the States have water pollution control statutes giving comprehensive control authority to the State water pollution control agency, but some States are limited in their authority to abate only that pollution which endangers public health. Furthermore, in some instances, control authority can only be exercised after the damage has occurred; a potential danger cannot be prevented. In one State the authority of the control agency over municipal sources of pollution has been temporarily suspended by legislative action. This situation was brought about by the difficulties associated with financing abatement works to comply with the control authority's requirements. This problem of municipal financing is prevalent throughout the basin and warrants further study. It does not appear, however, that municipal financing is an insurmountable obstacle, as evidenced by the construction of waste treatment works by some municipalities.

As stated previously, efficient plant operation is important if the functional design of treatment works is to be fully realized. State legislation is generally lacking which would permit effective control by State water pollution control agencies over this important phase of pollution abatement. Furthermore, State appropriations are not sufficient to provide the professional staff to furnish the necessary supervisory services for treatment plant operation. This lack of personnel also limits the conduct of other desirable field work necessary to better define the over-all pollution control program.

The "Suggested State Water Pollution Control Act" recommended to the States for favorable consideration by the Council of State Governments in "Suggested State Legislation; Program for 1951" (November 1950) is recommended as a guide to such adjustments to State law as may be desirable in this connection.

The existing State laws do not authorize interstate compacts for the control of interstate pollution in the Tennessee Basin. Because many of the most serious pollution problems in the basin are interstate in their effects and because interstate action can best cope with such problems, specific enabling legislation would no doubt encourage the formation of desirable interstate compacts.

Although the public may have a general awareness of stream pollution in the basin, the majority are not fully cognizant of the damages which existing water pollution is imposing on the other water uses, and the economy of the basin or the benefits which would be derived by restoring the damaged waters to productive uses. A program of public education designed to better inform the man on the street concerning his stake in the over-all pollution control program would serve to create a greater public demand for pollution abatement.

The cost of required pollution abatement projects is a primary factor affecting progress in the abatement program. Estimates of costs by individual projects, based on detailed knowledge of specific requirements, would be necessary to reflect the magnitude of financial difficulties which might be encountered. Such estimates, for the most part, are not available. A general estimate, for the basin as a whole and based on average cost data, would serve to indicate the economic impact of the program and to show the comparative cost between the Tennessee River Basin and other major river basins. Such an estimate can be made for municipalities within accuracy limits suitable for the purpose. Estimates of cost for industrial waste treatment requirements will be, at best, only a fair guess.

In analyzing the cost of municipal treatments plants, basic data obtained in the preparation of the Ohio River Survey Report (H. Doc. 266, 78th Cong., 1st sess.) were revised to present-day cost indices and compared with costs for a limited number of plants for which detailed costs were available from the State agencies. Curves derived from these sources showed a fairly close correlation and form the basis for a general estimate of municipal treatment plant costs for the basin as a whole. From the data available, it is indicated that intercepting sewer costs will exceed treatment plant costs. Another factor in estimating costs is the degree of treatment required. Separation of projects into primary and secondary treatment plants was accomplished, for the purpose of estimating costs, by consideration of the location of municipalities with respect to stream flows. Although this separation is subject to revision following detailed consideration of treatment requirements, the general estimate would not be materially affected.

It is estimated that the initial cost of required municipal treatment plants in the Tennessee River Basin will be approximately $15,400,000. This estimate includes those municipalities where revisions to existing plants are required and includes treatment of industrial waste now connected to municipal sewerage systems. The cost of intercepting sewers is estimated at about $26,300,000. Based on very limited data, it is expected that initial costs of industrial waste treatment, exclusive of industrial waste now connected to municipal sewerage systems, will be between $5,000,000 and $10,000,000. The total initial cost of required municipal and industrial waste treatment facilities, including necessary intercepting sewers but excluding collection systems, is estimated at from $47,000,000 to $57,000,000.

Recognizing that these expenditures will take place over a number of years, the estimated costs will be increased due to added factors. These include additional annual obsolescence and rehabilitation requirements, needs of communities installing new sewer systems, normal population increases and industrial expansion, as well as allowance for presently undetermined needs.

Table G - Requirements for municipal and industrial waste treatment plants

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	102*	617,452	83
Enlargement or additions to existing plant	17	33,285	8
Replace existing plant	16	60,100	1
No project required	32	63,440	19
Undetermined	34#	22,849	37

* Includes 1 municipality for which no population estimate is available. # Includes 5 communities having no comprehensive sewerage system. These communities have an estimated combined population of 1,339.

Table H - Status of treatment works project to abate pollution - July 1, 1950

Status of project*	Number	
	Municipal	Industrial(.)
No formal action	77	65#
Abatement ordered	0	1
Plans under preparation	21	13
Final plans approved	4**	2
Construction awaiting financing	13	25
Under construction	5	1
Status undetermined	49	22

* Projects required for pollution abatement may have proceeded

(Footnotes cont.)

(Footnotes for Table H cont.)

through several of the stages indicated, but are listed only once at the most advanced stage.

** Includes 2 municipalities to be served by 1 treatment plant.

# Includes 3 industries which were recently reported connected to city sewerage system.

(.) Present plans indicate that at least 25 to 30 industrial plants will be connected to municipal sewerage systems.

SUB-BASIN REPORTS

TENNESSEE RIVER MAIN STEM AND MINOR TRIBUTARIES SUB-BASIN

General Description - The Tennessee River is formed by the confluence of the French Broad and Holston Rivers at Knoxville, Tenn. It then flows in a southwesterly direction to Guntersville, Ala., thence in a westerly direction through the northern part of Alabama and northerly between Alabama and Mississippi and across the western part of Tennessee and Kentucky to enter the Ohio River at Paducah, Ky. The drainage area of the main stem of the Tennessee River, exclusive of the area drained by its major tributaries, is 16,521 square miles. Portions of the States of Alabama, Georgia, Kentucky, Mississippi and Tennessee are included in the sub-basin.

Economic Development - Economic activity in the sub-basin is diversified. The eastern section of the sub-basin is quite industrialized, while the central and western portions are predominately agricultural. In the past twenty years there has been an increasing variety in agricultural products. Industrial activity is centered mainly around the two large cities of Knoxville and Chattanooga. The types of industry in the area include textile plants, chemical manufacturing plants, food processing and packing plants, fabricated metal products, and other miscellaneous types of industry. Availability of cheap power will probably tend to increase industrial development in the area.

Rainfall and Run-off - The average annual precipitation in the sub-basin varies from 47 to 55 inches. The average for the area is about 52 inches per year. Stream flow is regulated by the operation of the various reservoirs to carry out the multiple-purposes of flood control, navigation and power production. Regulation for power purposes may result in considerable fluctuation in flows between peak load and off-load periods. Further study is required to determine proper relations between low flows desirable for dilution purposes and other purposes in some areas, particularly below Knoxville and Chattanooga.

Major River Developments - Since the authorization of the Tennessee Valley Authority, major developments of the water resources have been made. The river has been canalized for navigation for its entire length, a distance of about 650 miles. Nine high dams and reservoirs and one low dam are used for flood control, power development, and navigation. Incidental uses include fishing, boating, swimming, and other recreational uses.

Population - The 1940 population of the sub-basin was approximately 1,059,400. The 1940 population in municipalities, including mill villages, institutions, sanitary districts, and other population centers, was approximately 416,000.

Water Uses - Twenty-eight municipalities obtain public water supplies from surface sources and serve an estimated population of 394,600. Some of these supplies are from streams below sources of pollution. Other water uses include industrial and livestock water supplies, game and commercial fishing, boating, bathing and other recreational uses, and wildlife. As previously indicated, the water is used for navigation and power development.

Sources of Pollution - Fifty-four municipal sources of pollution, with a sewer connected population of 4[illegible]0, 810, contribute a pollution load of 640,000 equivalent population to the streams. Six other municipalities, with a sewer connected population of 9,300, discharge an undetermined amount of waste to the streams. Thirty-four industrial sources of pollution contribute an estimated pollution load equivalent to a population of 306,180. Four industrial plants contribute an undetermined quantity of organic wastes to the streams. Twenty-seven industrial plants contribute inorganic wastes to the streams. Eight of these plants are included in those discharging organic wastes.

Effects of Pollution on Water Uses - The most significant pollution effects occur in the industrial areas such as Knoxville and Chattanooga in Tennessee, and Huntsville, Decatur and the Tri Cities (Florence, Sheffield, and Tuscumbia) in Alabama. The sewage and industrial wastes from other sources are discharged at isolated points and result only in certain localized or special effects. Some of the smaller tributaries are quite polluted for short stretches. In the Knoxville area the pollution entering the river damages it for a considerable length. For a distance of over 40 miles, the river below Knoxville is not suitable for use as a water supply or a recreational area. The pollution problem in the Chattanooga area is even worse than it is at Knoxville. Although the river is large and capable of taking large amounts of pollution, at times of low flow considerable damage is done to the stream. Some of the creeks in and adjacent to the city are so grossly polluted that they present health hazards and nuisance problems. The main river in this area is unfit for certain kinds of fishing and for general recreational use.

Treatment Provided - Twenty-five municipalities have primary sewage treatment plants which serve a population of 55,915. Eleven municipalities have secondary treatment and serve a population of 31,625. Twenty-four municipalities, having a sewer connected population of 372,570, have no sewage treatment. The two largest municipalities, Chattanooga and Knoxville, having a combined connected population of about 270,000, have no treatment. Six of the fifty-seven industrial plants have waste treatment facilities. These six installations discharge only a small part of the total industrial wastes. Thirteen of the municipal treatment plants are satisfactory, 18 are unsatisfactory, and the status of 5 are undetermined. Two industrial treatment facilities are satisfactory, one is unsatisfactory, and the status of three are undetermined.

Treatment Plants Required - Table G(1) indicates treatment plant requirements in the sub-basin. Twenty-five new plants, eight enlargements or additions, and nine replacements are required at municipal sources of pollution. Requirements for five municipalities have not been determined. Forty-one new treatment facilities are required for industrial plants. Requirements at 13 locations are undetermined.

Tabular Data - Tables A(1) through I(1) present data relative to the pollution of the streams in the area. It is expected that the indicated number of treatment plants required will be reduced considerably by connection of industrial wastes to municipal systems.

Table A (1) - Sources of pollution - Municipal

Municipalities*	Sources of pollution (In number of municipalities)	Population served by sewerage system	Amount of pollution discharged to water-course (In terms of equivalent number of people) **
Having data on pollution load discharged to watercourse	54	450, 810	639, 975
Having population data available (Data on pollution load to water-course incomplete or not available)	6 #	9, 300	Not applicable.
Total	60 #	460, 110	-------

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers. ** Includes industrial wastes discharged into municipal sewerage systems.

Includes 2 municipalities which are sources of pollution but for which no population estimates are given.

Table B (1) - Sources of pollution - Industrial *

Industries	Sources of pollution (In number of plants)	Amount of pollution discharged to watercourse (In terms of equivalent number of people)
Producing organic wastes	34**	306, 180
Producing organic wastes	4	Undetermined.
Producing inorganic wastes	27	Not applicable.
Producing wastes of undetermined type	0	Undetermined.
Total	57 #	----------

* Industries having separate outlets and discharging wastes directly to watercourse. ** Includes 8 plants also producing inorganic wastes. # Total adjusted to correct for duplication noted in footnote marked thus, *.

Table $C_{(1)}$ - Existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	25	25	55,915
Secondary	11**	12	31,625
No treatment	24**	-----	372,570

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

** Includes 1 municipality for which no population estimates are given.

Table D(1) - Existing treatment facilities - Industrial *

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products ---	9	2	7	0
Textile mill products -----------	20	0	20	0
Lumber and wood products ------	1	0	1	0
Paper and allied products -----	1	0	1	0
Chemicals and allied products -----	9	3	5	1
Products of petroleum & coal ---	2	0	2	0
Leather and leather products ----	1	0	1	0
Primary metal industries----------	3	0	2	1
Fabricated metal products -----	4	0	4	0
Miscellaneous ------	7	1	6	0
Total --------	57	6	49	2

* Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_{(1)}$ - Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	36	13	18	5	28	3	5
Industrial	6	2	1	3*	2	1	3

* One of these industries is listed in Table $G_{(1)}$ under "No Project Required."

Table $F_{(1)}$ - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (In terms of equivalent number of people)
1946	0	---------	0	---------
1947	0	---------	0	---------
1948	1	1,000	2	16,300
1949	1	11,630	0	---------

Table G(1) - Requirements for municipal and industrial waste treatment plants

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	25*	371, 750	41
Enlargement or additions to existing plant	8	15, 860	0
Replace existing plant	9	36, 700	0
No project required	13*	29, 775	3**
Undetermined	5	6, 025	13

* Includes 1 municipality for which no population estimate is given.

** Includes 1 industry which is inactivated at present time.

Table H(1) - Status of treatment works project to abate pollution - July 1, 1950

Status of project	Number	
	Municipal	Industrial #
No formal action	21	18**
Abatement ordered	0	0
Plans under preparation	10	5
Final plans approved	3*	0
Construction awaiting financing	5	21
Under construction	0	0
Status undetermined	8	10

* Includes 2 municipalities to be served by one treatment plant.

** Includes 3 industries which were recently reported connected to city sewerage system. # Present plans indicate that at least 20 industrial plants will be connected to municipal systems.

Table I$_{(1)}$ - Project list - Municipalities and industries requiring improvements for abatement of pollution - July 1, 1950

Name	Population served*	Project requirements	Remarks
Tennessee:			
Savannah ------	2, 300	New plant----	------------
Lawrenceburg --	3, 600	Enlarge existing plant.	------------
Lexington ------	2, 500	New plant----	------------
Bruceton ------	1, 350	New plant----	------------
Paris ----------	8, 000	Replace existing plant.	------------
Lupton City ----	1, 100	Replace existing plant.	------------
Chattanooga ----	113, 000	New plant----	(**)
American Cyanamid & Chemical Co.---	0	Undetermined.	(**)
Carter Brothers	100	New plant----	(**)
Cavalier Corp. -	0	New plant----	(**)
Ray-Ser Dyeing Co.------------	50	New plant----	(**)
Samuel Stamping & Enameling Co.	0	New plant----	(**)
Signal Knitting Mills ----------	1, 700	New plant----	(**)
Tennessee Paper Mills ----------	12, 000	New plant----	(**)
U. S. Pipe and Foundry -------	0	New plant----	(**)
Red Bank ------	6, 000	New plant----	------------
South Pittsburg -	750	New plant----	------------
Kingsboro Silk Mills ----------	300	New plant----	------------
A. D. Adair Co. -	0	Undetermined.	(**)
Chattanooga Imp. & Mfg. Co.-----	0	Undetermined.	(**)
Sterchi & Sons Dairy ---------	Undetermined.	New plant----	(**)
United Hosiery Mills ---------	450	New plant----	(**)

(Table I$_{(1)}$ - Continued)

Table I$_{(1)}$ – (Continued)

Name	Population served *	Project requirements	Remarks
Dixie Mercerizing Co.	1, 400	New plant	(**)
Lookout Oil and Refining Co.	5, 700	New plant	(**)
Reilly Tar and Chemical Corp.	1, 300	New plant	(**)
Robert Scholze Tannery	16, 000	New plant	(**)
Southern Chemical Cotton Co.	132, 000	New plant	(**)
Southern Wood Preserving Co.	0	New plant	(**)
Tennessee Products & Chemical Corp.	44, 000	New plant	(**)
Tennessee Stove Works	0	New plant	(**)
Wilson & Co.	1, 400	New plant	(**)
Sewanee	1, 300	Replace existing plant.	------------
Ardmore Creamery	130	Undetermined.	------------
Knoxville (part)	157, 000	New plant	4, 000 to Holston.
Tenn. Marble Co.	0	New plant	------------
East Tenn. Packing Co.	15, 000	New plant	------------
Condro Marble Co.	0	New plant	------------
Rohm & Hass	5, 400	New plant	------------
U. of Tenn. Dairy	Undetermined.	New plant	------------
Eastern State Hospital	2, 400	New plant	------------
Loudon	3, 500	New plant	------------
Chas. H. Bacon Co.	3, 500	New plant	------------
Watts Bar Dam Village	160	Add to existing plant.	------------
Standard Knitting Mills	4, 050	New plant	------------

(Table I$_{(1)}$ - Continued)

Table $I_{(1)}$ - (Continued)

Name	Population served *	Project requirements	Remarks
Bureau of Gas (Knoxville) -----	5, 000	New plant----	-------------
Southern Railway Co. -------	0	Undetermined.	-------------
M. Leicht Co. --	Undetermined.	Undetermined.	-------------
Appalachian Marble Co. ----	0	New plant----	-------------
Gray-Knox Marble Co. ----	0	New plant----	-------------
Fulton Sylphon Co.	0	New plant----	-------------
Maryville ------	7, 300	Replace existing plant.	-------------
Alcoa----------	4, 000	Replace existing plant.	(#)
Aluminum Co. of America-----	0	Undetermined.	-------------
Lenoir City ----	5, 600	Replace existing plant.	-------------
Sweetwater ----	3, 200	Replace existing plant.	-------------
Sweetwater Hosiery Mills ------	200	New plant----	-------------
Philadelphia Hosiery Mills-------	300	New plant----	-------------
Rockwood -------	2, 200	Replace existing plant.	-------------
Southern Silk Mills -----------	200	New plant----	-------------
Rockwood Mill---	1, 100	New plant----	-------------
Alabama:			
Bridgeport -----	295	New plant----	-------------
Guntersville ----	3, 200	New plant----	-------------
Farley ---------	1, 200	Enlarge existing plant.	-------------
Decatur---------	21, 500	New plant----	-------------
Wheeler Dam Village ---------	200	New plant----	-------------

(Table $I_{(1)}$ - Continued)

Table I$_{(1)}$ - (Continued)

Name	Population served *	Project requirements	Remarks
Wheeler Dam Village #2	3, 000	New plant	-------------
Florence (part)	10, 500	New plant	-------------
Sheffield	7, 250	New plant	-------------
Scottsboro	2, 000	Enlarge and add to existing plant.	-------------
Huntsville	23, 000	New plant	-------------
Huntsville Mfg. Co. (MV)	4, 000	Replace existing plant.	Mill village.
Hartselle	2, 000	Add to existing plant.	-------------
Athens	3, 100	New plant	-------------
Moulton	900	Add to existing plant.	-------------
Courtland Housing Unit	225	Undetermined.	-------------
Lister Hill	3, 000	Undetermined.	-------------
Electro-Metallurgical Co.	0	Undetermined.	-------------
TVA Chemical Plant	0	Undetermined.	-------------
Florence (part)	4, 500	Enlarge existing facilities.	-------------
Tuscumbia (part)	5, 700	New plant	-------------
Tuscumbia (part)	425	New plant	-------------
TVA Village # 1	500	New plant	-------------
Russellville	2, 000	New plant	-------------
Russellville Mills	280	New plant	Mill village.
Kentucky:			
Kentucky State Park	-----	New plant	-------------
Shoarts Bros.	100	New plant)	Recently reported connected to city sewers.
Murray Milk Prod. Co.	100	New plant)	
Murray Hosiery Mills, Inc.	100	New plant)	

(Table I$_{(1)}$ - Continued)

Table $I_{(1)}$ - (Continued)

Name	Population served *	Project requirements	Remarks
Benton --------	1, 500	Add to existing facilities.	--------------
Penn Salt Co.---	-----	Undetermined.	--------------
Georgia:			
Yates Bleachery	1, 200	Undetermined.	--------------
Rossville ------	2, 000	New plant----	(.)
Richmond Hosiery Mills -----	1, 000	New plant----	(.)
Hosiery Processing Co. ----	1, 200	New plant----	(.)
Peerless Woolen Mills ----------	46, 000	New plant----	(.)
Standard Coasa Thatcher ------	900	New plant----	(.)
Chickamauga ---	1, 200	Undetermined.	--------------
Crystal Springs Bleachery------	6, 400	Undetermined.	--------------
Ft. Oglethorp --	500	Undetermined.	--------------
Ringgold -------	100	Undetermined.	--------------
Wintuft Corp.---	300	Undetermined.	--------------

---

* Organic industrial waste load is expressed as population equivalent as measured by B. O. D. ** Primary treatment and interceptor planned for Chattanooga. When installed, as many industries as possible will discharge to municipal sewer. # Alcoa has two treatment plants. One, serving a population of 4, 100, is satisfactory. (.) An engineering report has been prepared which includes these sources of pollution and the City of Chattanooga in a metropolitan sewerage project.

HOLSTON RIVER SUB-BASIN

General Description - The North Fork and South Fork join to form the Holston River below Kingsport in northeastern Tennessee. The headwaters of the South Fork are in Virginia near Sugar Grove and the headwaters of the North Fork are above Saltville, Va. The Watauga River is the other main tributary of the Holston River. This tributary has headwaters in North Carolina and joins the South Fork about 10 miles below Bluff City, Tenn. From Kingsport, the Holston River flows in a southwesterly direction about 85 miles (airline) to join the French Broad River and form the Tennessee River above Knoxville, Tenn. The area of the sub-basin is 3,776 square miles; 2,207 square miles being in Tennessee, 1,400 in Virginia, and 169 in North Carolina. The headwaters of the South Fork and Watauga Rivers are in the Blue Ridge Mountain region, while the remainder of the sub-basin is in the so-called valley of Eastern Tennessee, and is characterized by long narrow ridges lying in a northeast-southwest direction parallel to the general axis of the sub-basin.

Economic Development - Economic activity in the sub-basin includes agriculture, food processing plants, chemical plants, and miscellaneous industrial plants. The population in the sub-basin is predominantly rural, but the area is one of the most highly industrialized sections of the Tennessee Basin.

Rainfall and Run-off - The average annual precipitation in the subbasin is between 44 and 45 inches per year, the average being fairly uniform over the area.

Records from United States Geological Survey gaging stations on the main stem and major tributaries present adequate data on stream flows in these streams. Several of the sources of pollution are located on small tributaries where stream flow records are scarce. Flows on the main stem and parts of the South Fork and Watauga Rivers are regulated by reservoir operation.

Major River Developments - Four hydroelectric and flood control reservoirs comprise the major river developments in the sub-basin. One, the Cherokee, is located on the main stem below major sources of pollution. The other three, the South Holston on the South Fork (not yet completed) and the Watauga and Wilbur on the Watauga River, are above major sources of pollution. In fact, over half of the organic pollution in the sub-basin enters the streams below these points. The Cherokee Reservoir operation has very little effect on waste treatment requirements in the sub-basin. Information is not available at this time as to the effect of the operation of the other reservoirs on waste treatment requirements. Two other dams are to be constructed on the South Fork of the Holston between the mouth of the Watauga River and Kingsport.

Population - The 1940 population in the sub-basin was 348,722, divided by States as follows: Tennessee - 240,501; North Carolina - 12,714; and Virginia - 90,507. The 1940 population in 21 municipalities contributing significant pollution to the streams was about 107,591. Considerable increase in the urban population has taken place since 1940.

Water Uses - The waters of the sub-basin are used for domestic, industrial, and livestock water supplies and for recreational purposes, particularly game fishing. Many of the industries obtain their water supplies from municipal systems, while others obtain their supplies directly from the streams. The small streams are extensively used for game fishing and the reservoirs referred to above are increasingly being used for fishing. Four municipalities have surface water supplies which serve a population of 53,100. In addition, there are other smaller supplies serving an undetermined number of people.

Sources of Pollution - Twenty-one municipal sewerage systems discharge an estimated population equivalent waste load to the streams of about 121,000. Eighteen industrial plants discharge an organic waste load having a population equivalent of 538,000. Eight other plants discharge an unestimated load to the streams. Eleven plants discharge inorganic wastes, five of which also discharge organic wastes. It is apparent that industrial wastes far exceed domestic wastes in the sub-basin. Most of the waste in the sub-basin originates in the State of Tennessee. The largest source of organic pollution in Virginia is at Bristol on the Tennessee-Virginia border. Over one half of the organic pollution in the sub-basin originates at Kingsport, Tenn. and vicinity. Another 30 to 35 percent enters the South Fork and Watauga Rivers and tributaries in Tennessee. The pollution load discharged to the streams in the sub-basin at present is more than double that reported in 1940.

Effects of Pollution on Water Uses - In some sections pollution of the streams renders them unsuitable for domestic or municipal water supply. Complaints that the streams in certain areas are unfit for livestock water supplies have been made. The North Fork of the Holston receives little organic wastes, but the water is unsuitable for public water supplies and other purposes due to inorganic dissolved solids discharged by industry. The Holston River is polluted all the way to Cherokee Reservoir, due principally to the pollution load entering the South Fork at Kingsport. The heavy pollution entering the South Fork at Bristol and the Watauga River at and in the vicinity of Elizabethton and Johnson City adversely affects the Kingsport water supply at times.

Treatment Provided - Of the 21 municipalities discharging significant wastes to the streams, 15, with a population served of 90,970, have no treatment; one, with a population served of 720, has secondary treatment; and 5, with a population served of 15,200, have primary treatment. Four of the municipal plants are satisfactory and two are unsatisfactory. Eight industrial plants out of 31 contributing wastes to the streams have treatment facilities. Two of these are unsatisfactory and the status of 6 is undetermined. Three industrial plants contribute about 90 percent of the industrial waste load to the streams. One of these has no treatment, one has unsatisfactory treatment, and the status of one is undetermined.

Treatment Plants Required - Table $G_{(2)}$ indicates treatment requirements in the sub-basin. Fourteen new plants and one enlargement to an existing plant are required at municipal sources of pollution and 17 at industrial sources. Requirements at two municipalities and 13 industrial plants are undetermined.

Tabular Data - Tables $A_{(2)}$ through $I_{(2)}$ contain data relative to pollution of the streams of the sub-basin.

Table $A_{(2)}$ - Sources of pollution - Municipal

Municipalities*	Sources of pollution (In number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (In terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	21	106,890	120,920
Having population data available (Data on pollution load to watercourse incomplete or not available)	0	---	Not applicable.
Total	21	106,890	---

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers. ** Includes industrial wastes discharged into municipal sewerage systems.

Table $B_{(2)}$ - Sources of pollution - Industrial*

Industries	Sources of pollution (In number of plants)	Amount of pollution discharged to watercourse (In terms of equivalent number of people)
Producing organic wastes	18**	537,750
Producing organic wastes	8#	Undetermined.
Producing inorganic wastes	11	Not applicable.
Producing wastes of undetermined type	1	Undetermined.
Total	38( )	---

* Industries having separate outlets and discharging directly to

(Footnotes cont.)

(Footnotes for Table $B_{(2)}$ cont.)

watercourse.

** Includes 5 plants also producing inorganic wastes.

# Includes 2 plants also producing inorganic wastes.

(.)Total adjusted to correct for duplication noted in footnotes marked thus, ** and thus, #.

Table $C_{(2)}$ - Existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	5	5	15,200
Secondary	1	1	720
No treatment	15	---	90,970

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

Table $D_{(2)}$ - Existing treatment facilities - Industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products --	7	2	5	0
Textile mill products ---------	4	0	4	0
Paper and allied products----	2	1	1	0
Chemical and allied products----	5	4	1	---
Leather and leather products --	3	1	2	---
Zinc mining ------	1	0	1	0
Miscellaneous ----	6	0	6	0
Undetermined ----	3	0	3	0
Total ---------	31	8	23	0

* Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_{(2)}$ - Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satis-factory	Unsatis-factory	Unde-termined	Satis-factory	Unsatis-factory	Unde-termined
Municipal	6	4	2	0	3	0	3
Industrial	8	0	2*	6	2	0	6

* One of these plants is listed in Table $G_{(2)}$ under "No Project." Correction can be obtained by operating changes.

Table $F_{(2)}$ - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (In terms of equivalent number of people)
1946	0	---	0	---
1947	0	---	0	---
1948	0	---	0	---
1949	0	---	3*	87,300*

* One of these plants is the Mead Corporation at Kingsport, which has accomplished substantial waste reduction through process changes.

Table $G_{(2)}$ - Requirements for municipal and industrial waste treatment plants

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	14	90,930	16
Enlargement or additions to existing plant	1	3,000	1
Replace existing plant	0	---	0
No project required	4	12,720	1
Undetermined	2	240	13

Table $H_{(2)}$ - Status of treatment works project to abate pollution - July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	6	17
Abatement ordered	0	0
Plans under preparation	3	5*
Final plans approved	1	1**
Construction awaiting financing	3	3#
Under construction	0	0
Status undetermined	4	4

* Four industrial plants to be connected to city sewers.

(Footnotes cont.)

(Footnotes for Table $H_{(2)}$ cont.)

** One industrial plant to be connected to city sewers.

# Three industrial plants to be connected to city sewers.

Table $I_{(2)}$ - Project list - Municipalities and industries requiring improvements for abatement of pollution - July 1, 1950

Name	Population served *	Project requirements	Remarks
Tennessee:			
Holston Ordnance Works	------------	Undetermined.	Not in operation at present.
Rogersville	1,700	New plant	------------
Morristown	12,000	New plant	------------
Knoxville (part)	4,000	New plant	157,000 to Tennessee R. Main Stem Sub-Basin.
Bluff City	930	New plant	------------
Tenn. Eastman Corp.	360,000	New plant	------------
Blue Ridge Glass Co.	500	New plant	------------
Kingsport	18,000	New plant	------------
Bristol	8,150	New plant	Part in Tenn. only.
American Thread Co.	150	New plant	------------
Elizabethton	7,500	New plant	------------
American Bemberg Corp.	1,300	New plant	Chemical corporation.
North American Rayon Corp.	77,000	Add to existing facilities.	------------
Gloria Rayon Mills	200	New plant	------------
Johnson City Mills	75	New plant	------------
Johnson City	23,000	New plant	------------
Slip-Not Belting Co.	------------	Undetermined.	Leather products.
C. D. Bridwell Packing Co.	1,200	New plant	------------
Mead Corp.	86,000	New plant	Paper mill.
Clinchfield Stone Co.	------------	New plant	Silt waste.
Pet Milk Co.	200	New plant	------------

(Table $I_{(2)}$ - Continued)

Table I(2) - (Continued)

Name	Population served*	Project requirements	Remarks
Hawkins County Creamery -----	----------	Undetermined.	-------------
Dean Canning Co. -----------	2,000	New plant ---	-------------
Ideal Oak Leather Co. ---	Closed at present	Undetermined.	May reopen.
Stokely Foods, Inc. ----------	6,600	New plant ---	-------------
American Zinc Co. -----------	----------	Undetermined.	-------------
Southern Railway	----------	Undetermined.	No information on waste.
Virginia:			
Saltville ------	1,500	New plant ---	-------------
Plasterco ----	200	New plant ---	-------------
Emory -------	650	New plant ---	-------------
Gate City ----	2,300	New plant ---	-------------
Sugar Grove --	40	Undetermined.	-------------
Damascus ----	200	Undetermined.	-------------
Damascus Hosiery Mills -	----------	Undetermined.	-------------
American Cyanamid Corp.	2,000	Undetermined.	Chemical wastes.
Marion Mfg. Corp. --------	200	Undetermined.	-------------
Brunswick-Balke Collender Co.-	200	Undetermined.	-------------
Service Dry Cleaners -----		Undetermined.	-------------
Chilhowie ----	1,000	New plant ---	-------------
B.B. Huff Co.-	----------	Undetermined.	Slaughterhouse.
Pet Milk Co. (Abingdon) ----	----------	New plant ---	-------------
Abingdon -----	3,000	Enlarge existing plant.	-------------
Bristol -------	10,000	New plant ---	-------------

(Table I(2) - Continued)

Table $I_{(2)}$ - (Continued)

Name	Population served *	Project requirements	Remarks
Columbian Paper Co. -----	----------	New plant ---	------------
Charles A. Schieren Co.---	----------	New plant ---	Tannery.
Universal Moulded Products Corp. ---------	----------	Undetermined.	------------
Norfolk & Western Railway Co. (Bristol) ------	125	New plant ---	Also equipment cleaning wastes.

* Organic industrial waste load is expressed in terms of population equivalent as measured by B.O.D.

FRENCH BROAD RIVER SUB-BASIN

General Description - The French Broad River has its headwaters in western North Carolina, near the South Carolina border, and flows through eastern Tennessee to join the Holston River and form the Tennessee River. The sub-basin has an area of about 5, 100 square miles, approximately 2, 300 square miles being in Tennessee and the remainder in North Carolina. The sub-basin lies in a mountainous region, the lower part being somewhat less rugged than the upper part.

Economic Development - Economic pursuits in the sub-basin include agriculture, manufacturing plants and recreational development. Agricultural products are diversified and include meat and dairy products. The predominant industries include manufacture of textiles, wood products, pulp and paper, leather and leather products, and food. While the sub-basin is predominantly rural, it is becoming increasingly industrialized. The area is noted as a recreational and resort section.

Rainfall and Run-off - Rainfall varies widely in the sub-basin, the average for the sub-basin as a whole being approximately 50 inches per year, while the average for the upper section is over 75 inches and at the mouth of the river less than 40 inches. Several gaging stations are located in the river and the data from these stations are sufficient to define the low flow characteristics of the main river. Generally, the low flows are substantial with respect to the tributary drainage area, varying from about 0. 11 cubic feet per second per square mile above Douglas Dam at the lower part of the sub-basin to substantially more than that in the upper part of the sub-basin. The flows below Douglas Dam, one of the reservoirs in the Tennessee Valley Authority system, are regulated by the reservoir operation. Low flows are generally sufficient, particularly on the main stem, to maintain satisfactory water quality after reasonable waste treatment has been provided.

Major River Developments - The river is not developed for navigation. One large reservoir has been developed in the sub-basin. This reservoir is impounded by Douglas Dam, located in the lower part of the sub-basin, and is a part of the TVA development. There are some smaller private reservoirs located in the sub-basin. There are apparently no substantial effects on treatment requirements for pollution abatement through flow regulation by present or anticipated upstream river developments.

Population - The 1940 population in the sub-basin was about 372,000. The 1940 population in municipalities contributing significant wastes to the streams was about 114,000. These population figures are subject to considerable variation due to influx of summer visitors for recreation purposes.

Water Uses - Waters in the sub-basin are used for domestic, industrial, and livestock water supplies, and for fishing, bathing and other recreational uses. Seventeen public water supplies from surface sources serve a population of about 120,000. These supplies serve 24 municipalities and sanitary districts. Other surface water supplies serve smaller population centers. A large quantity of industrial water supply is obtained from surface streams, principally for use in paper mills and rayon plants. The sub-basin is popular as a resort area and recreational uses of the waters are important reasons for pollution abatement.

Sources of Pollution - An estimated industrial waste load of 235,400, measured in terms of population equivalent, and an estimated domestic sewage load of 162,000, is discharged to the streams of the sub-basin. Approximately half of the industrial waste load is discharged into the headwaters of the river near Brevard, N. C., most of which originates at one plant. Another 25 percent of the industrial load is discharged from a plant in the upper part of the Pigeon River. The load from this plant has been reduced to the present value in the past 3 or 4 years from an original load estimated to be about 5 times as great. This reduction in waste load has resulted from changes in plant operation and processes rather than treatment of wastes.

Effects of Pollution on Water Uses - Waste discharges adversely affect uses of water in practically the full length of the main stem of the French Broad River and of Pigeon River. Douglas Dam is located on the French Broad River below the major sources of pollution, and it is reported that the discharge from the penstock is completely devoid of oxygen at times. The other main tributary of the French Broad River, namely the Nolichucky River, is reported to receive comparatively little organic pollution. However, there is some indication that turbidity and acid waste from mining operations cause some damages. The extent of these damages is not well defined, at present. Generally, pollution in the streams does not cause a great amount of damage to existing domestic water supplies, since most of these are located above major sources of pollution. However, Newport is denied the use of the Pigeon River as a source of water supply which it badly needs at this time. Some damage occurs to the Greeneville water supply from the above-mentioned operations on the Nolichucky River. Color resulting from pollution damages recreational and other uses of the streams.

Treatment Provided - Five primary sewage treatment plants serve five municipalities and a population of 2,975. Three secondary treatment plants serve three municipalities and a population of 6,100. Twenty-five municipalities, with a population served of 96,865, have no treatment. Four of the 11 industrial plants provide treatment of wastes. Six of the municipal plants are satisfactory, one is unsatisfactory, and the status of one is undetermined. One of the industrial treatment plants is satisfactory, one is unsatisfactory, and the status of two undetermined. Tables $C_{(3)}$, $D_{(3)}$, and $E_{(3)}$ contain data on existing treatment facilities.

Treatment Plants Required - Table $G_{(3)}$ indicates treatment requirements in the sub-basin. Twenty new treatment plants and two additions to existing plants at municipal sources of pollution are required. Seven industrial sources of pollution require new treatment facilities and one requires additions to present treatment. Requirements at five municipalities and two industrial plants have not been determined.

Tabular Data - Tables $A_{(3)}$ through $I_{(3)}$ contain additional data relative to pollution of the streams in the sub-basin. The municipal sources of pollution include several sanitary districts, each of which may serve several municipalities. Each sanitary district is listed as one source of pollution.

Table A$_{(3)}$ - Sources of pollution - Municipal

Municipalities*	Sources of pollution (In number of municipalities)#	Population served by sewerage system	Amount of pollution discharged to watercourse (In terms of equivalent number of people) **
Having data on pollution load discharged to watercourse	31	105, 165	161, 635
Having population data available (Data on pollution load to watercourse incomplete or not available)	2	775	Not applicable.
Total	33	105, 940	------------

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers. ** Includes industrial wastes discharged into municipal sewerage systems. # Includes several sanitary districts, serving an undetermined number of municipalities and other political subdivisions, each of which is listed as one source of pollution.

Table B$_{(3)}$ - Sources of pollution - Industrial *

Industries	Sources of pollution (In number of plants)	Amount of pollution discharged to watercourse (In terms of equivalent number of people)
Producing organic wastes	10 **	235, 400
Producing organic wastes	1	Undetermined.
Producing inorganic wastes	1	Not applicable.
Producing wastes of undetermined type	0	Undetermined.
Total	11 #	------------

* Industries having separate outlets and discharging waste directly to watercourse. ** Includes 1 plant also producing inorganic wastes. # Total adjusted to correct for duplication noted in footnote marked thus, **.

Table C$_{(3)}$ - Existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	5	5	2,975
Secondary	3	3	6,100
No treatment	25	-----	96,865

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers.

Table D$_{(3)}$ - Existing treatment facilities - Industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products ----	5	1	4	0
Textile mill products -----------	1	0	1	0
Paper and allied products -----	2	1	1	0
Chemical and allied products -----	1	1	0	0
Leather and leather products ----	2	1	1	0
Total --------	11	4	7	0

*Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_{(3)}$ - Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	8	6	1	1	7	0	1
Industrial	4	1	1	2	1	0	3

Table $F_{(3)}$ - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (In terms of equivalent number of people)
1946	0	-------	1*	2,400
1947	0	-------	0*	-------
1948	0	-------	0*	-------
1949	0	-------	0	-------

* In addition, between 1946 and 1948, one plant in North Carolina reduced waste discharge from equivalent population of 216,000 to 65,500 by revision in plant processes. Also, recent improvements have resulted in substantial reduction in industrial waste load from the rayon plant at Enka, N. C.

Table G(3) - Requirements for municipal and industrial waste treatment plants

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	20	88, 015	7
Enlargement or additions to existing plant	2	1, 350	1
Replace existing plant	0	---------	0
No project required	6	7, 725	1
Undetermined	5	8, 850	2

Table H(3) - Status of treatment works project to abate pollution - July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	14	6
Abatement ordered	0	0
Plans under preparation	1	1
Final plans approved	0	0
Construction awaiting financing	1	0
Under construction	1	0
Status undetermined	10	3

Table I$_{(3)}$ - Project list - Municipalities and industries requiring improvements for abatement of pollution - July 1, 1950

Name	Population served*	Project requirements	Remarks
North Carolina:			
Brevard	2,800	New plant	Tannery waste equivalent of 2,880.
Enka	570	New plant	Rayon plant (9,300 population equivalent.)
Biltmore Estate	230	New plant	-------------
Biltmore Forest	475	New plant	-------------
Swananoa Sanitary District	11,000	New plant	-------------
Asheville	51,310	New plant	-------------
Beaver Dam Sanitary District	1,400	New plant	-------------
Crescent Hill Sanitary District	650	New plant	-------------
Hazel Sanitary District	1,250	New plant	-------------
Skyland Sanitary District	550	New plant	-------------
Weaverville	750	New plant	-------------
Mars Hill	500	Add to existing plant	-------------
Marshall	1,040	New plant	-------------
Hot Springs	600	New plant	-------------
Hendersonville	5,050	New plant	-------------
Spruce Pine	1,000	New plant	-------------
Burnsville	575	New plant	-------------
Bakersville	125	New plant	-------------
Canton	4,860	Undetermined.	-------------
Clyde	440	Undetermined.	-------------
Waynesville	2,300	Undetermined.	-------------
Hazelwood	1,050	Undetermined.	Tannery waste equiv. of 10,000.
Waterville	200	Undetermined.	-------------
Rossman Tannery	7,500	Add to existing plant.	-------------
Sayless Bl. & Finishing Mill	12,000	New plant	-------------

(Table I$_{(3)}$ - Continued)

Table $I_{(3)}$ - (Continued)

Name	Population served *	Project requirements	Remarks
Ecusta Paper Co.	108,000	New plant----	Plans under preparation.
Champion Paper & Fiber Co. ----	65,000	Undetermined.	-------------
Tennessee:			
Newport -------	3,000	New plant----	-------------
Erwin ---------	4,400	New plant----	-------------
Jonesboro -----	850	Add to existing plant.	-------------
Sieverville -----	1,240	New plant----	-------------
A. C. Lawrence Leather Co. ----	20,000	New plant----	-------------
Stokely Foods Co., Newport -------	8,200	New plant----	-------------
Pet Milk Co. ---	2,200	New plant----	-------------
Bush Bros. & Co.	7,200	New plant----	-------------
White Canning Co.	-----	Undetermined.	-------------
Stokely Foods Co., Sieverville -----	2,900	New plant----	-------------

---

* Organic industrial waste load is expressed in terms of population equivalent as measured by B. O. D.

LITTLE TENNESSEE RIVER SUB-BASIN

General Description - The Little Tennessee Sub-Basin is a long, narrow area lying just south of the French Broad River Sub-Basin and extending from northern Georgia northwesterly across western North Carolina into Tennessee. The Little Tennessee is the sixth largest tributary of the Tennessee River. Its waters join the main stream at Lenoir City, Tenn.

Most of the area of the sub-basin, more than 1, 800 square miles, lies in North Carolina. The State of Tennessee includes within its boundaries 799 square miles, or about 30 percent of the area. A small portion, about 45 square miles, is in northwestern Georgia. The entire sub-basin covers an area of approximately 2, 650 square miles.

Principal tributaries of the Little Tennessee are the Nantahala, Tuckaseegee, and Cheoah Rivers, draining areas of 175 square miles, 734 square miles, and 215 square miles, respectively. The Nantahala and Tuckaseegee watersheds lie wholly within North Carolina.

The topography of the sub-basin is for the most part rugged, mountainous terrain, ranging in elevation from 750 feet at the river mouth to over 5, 000 feet on the mountain summits. The river itself has an irregular gradient, dropping as much as 30 feet per mile in its steepest part and as little as 4 feet per mile at Morgantown, 12 miles above the river mouth. A large part of the Great Smoky Mountain National Park, the Cherokee National Forest and the Nantahala National Forest is in the Little Tennessee watershed.

Economic Development - The Little Tennessee River sub-basin is predominantly a rural and agricultural region, with no large towns and very few industrial developments. One food processing firm operates a cannery during the canning season at Tellico Plains, Tenn. In North Carolina there is a concentration of industries at Sylva, on Scott's Creek.

Rainfall and Run-off - The Little Tennessee drainage area has a higher average annual rainfall than any other of the main tributaries of the Tennessee. About 44 inches of precipitation occurs near the mouth, while in the upper valley 85 inches is the average rainfall. The average for the entire sub-basin is approximately 58 inches.

A considerable amount of run-off data has been recorded for the sub-basin. Gaging stations have been maintained at 18 locations on the Little Tennessee and its tributaries. Records for the station at McGhee, Tenn. over a period of 42 years(1905-47) indicate that the run-off from the drainage area above this point has had an average discharge of 5, 709 cubic feet per second. This flow, at a point about 18 miles above the mouth of the Little Tennessee, comes from an area of 2, 443 square miles, and includes the discharge from the Tellico River. The minimum recorded daily discharge for this gaging station was a regulated flow of 500 cubic feet per second in September, 1925. The flow at McGhee is regulated by many reservoirs above the station.

Major River Developments - The narrow valleys, together with abundant stream flows, provide exceptionally favorable conditions for hydroelectric projects. Six hydroelectric plants are operated in the sub-basin by the Aluminum Company of America and the Tennessee Valley Authority. The operation of these reservoirs for power and flood control is integrated through an agreement between TVA and the Aluminum Company.

Population - The Little Tennessee Drainage Sub-Basin had a population of 83, 350 in 1940, according to U. S. Census figures. The urban population is very small. Only one community, Franklin, N. C., had a population of 2, 500, the minimum population for which a community is classified as urban by the Bureau of the Census. The 1940 winter population of Franklin was only 1, 249.

The combined 1940 population of those communities discharging wastes to the Little Tennessee and its tributaries was approximately 12, 000.

Water Uses - Eight communities in North Carolina and one in Tennessee, with a total population of about 9, 000, use surface streams of the sub-basin as sources of public water supply. About 5, 000 persons live in towns obtaining public water supplies from ground sources. There is extensive use of the surface waters of the area for recreation, especially in the summer. Water from the several reservoirs provide the means for the production of electrical power in the hydroelectric plants previously mentioned.

Sources of Pollution - Eleven municipalities, with a population of 7, 270 served by sewerage systems, contribute wastes to the streams. Three industrial plants contribute a total organic waste load of 102, 300 equivalent population. Most of the pollution in the sub-basin occurs at Sylva, N. C.

This municipality has a population served of only 940, but the industrial waste load there has a population equivalent of 101,000.

Effects of Pollution on Water Uses - The pollution at Sylva affects the waters of Scott's Creek, Tuckaseegee River, and the Little Tennessee River below its junction with the Tuckaseegee River. The waters immediately below this source of pollution are high in color, appearing jet black at times, and are unfavorable for water supply uses and for fishing and recreation. At present there is no apparent need for public water supplies from this portion of the river. However, the stream is in a resort area and recreational uses are important.

Treatment Provided - Four municipalities, with a population served of 2,550, have primary treatment. Seven municipalities, with a population served of 4,720, have no treatment. The one municipality where the major industrial waste occurs has no treatment. There are no industrial waste treatment plants. Two municipal treatment plants are satisfactory, while the adequacy of the other two is undetermined.

Treatment Plants Required - Four new municipal treatment plants are required, and requirements at 5 municipalities are undetermined. One industrial plant requires treatment facilities. The requirements at 2 industries are undetermined.

Tabular Data - Tables $A_{(4)}$ through $I_{(4)}$ contain data relative to pollution in the sub-basin.

Table A (4) - Sources of pollution - Municipal

Municipalities*	Sources of pollution (In number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (In terms of equivalent number of people) **
Having data on pollution load discharged to watercourse	10	6,770	6,110
Having population data available (Data on pollution load to watercourse incomplete or not available)	1	500	Not applicable.
Total	11	7,270	-------------

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers.

** Includes industrial wastes discharged into municipal sewerage systems.

Table B (4) - Sources of pollution - Industrial*

Industries	Sources of pollution (In number of plants)	Amount of pollution discharged to watercourse (In terms of equivalent number of people)
Producing organic wastes	3	102,300
Producing organic wastes	0	Undetermined.
Producing inorganic wastes	0	Not applicable.
Producing wastes of undetermined type	0	Undetermined.
Total	3	-------------

* Industries having separate outlets and discharging directly to watercourse.

Table $C_{(4)}$ - Existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	4	4	2,550
Secondary	0	0	0
No treatment	7	--------------	4,720

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

Table $D_{(4)}$ - Existing treatment facilities - Industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products --	1	0	1	0
Paper and allied products ---	1	0	1	0
Leather and leather products --	1	0	1	0
Total --------	3	0	3	0

* Industries having separate outlets and discharging wastes directly to watercourse.

Table E (4) - Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satis-factory	Unsatis-factory	Unde-termined	Satis-factory	Unsatis-factory	Unde-termined
Municipal	4	2	0	2	2	0	2
Industrial	0	0	0	0	0	0	0

Table F (4) - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (In terms of equivalent number of people)
1946	0	-------------	0	------------
1947	0	-------------	0	------------
1948	0	-------------	0	------------
1949	0	-------------	0	-------------

Table $G_{(4)}$ - Requirements for municipal and industrial waste treatment plants

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	4	3,180	1
Enlargement or additions to existing plant	0	0	0
Replace existing plant	0	0	0
No project required	2	1,050	0
Undetermined	5	3,040	2

Table $H_{(4)}$ - Status of treatment works project to abate pollution - July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	4	1
Abatement ordered	0	0
Plans under preparation	0	0
Final plans approved	0	0
Construction awaiting financing	1	0
Under construction	1	0
Status undetermined	3	2

Table I$_{(4)}$ - Project list - Municipalities and industries requiring improvements for abatement of pollution - July 1, 1950

Name	Population served *	Project requirements	Remarks
North Carolina:			
Fontana Dam ---	1,000	Undetermined.	------------
Robbinsville ----	400	Undetermined.	------------
Tapoca --------	200	Undetermined.	------------
Cullowhee -----	1,140	New plant ---	------------
Cherokee Indian Reservation ----	500	Undetermined.	------------
Bryson City ----	1,610	New plant ---	------------
Sylva ----------	940	Undetermined.	------------
Mead Corporation	----------	Undetermined)	Combined tannery and pulp wastes with pop. equiv. of 101,000.
Armour Tannery	----------	Undetermined)	
Dillsboro ------	290	New plant ---	------------
Tennessee:			
Calderwood ----	140	New plant ---	------------
Stokely Foods Co.	1,300	New plant ---	------------

* Amount of industrial organic waste is reported in terms of population equivalent as measured by B.O.D.

CLINCH RIVER SUB-BASIN

General Description - The Clinch River Sub- Basin, draining an area of 4,413 square miles, is the second-largest of the seven major watershed areas tributary to the Tennessee River. The drainage sub-basin is a long, narrow valley, the axis of which lies in a northeast-southwest direction. The distance between the source, near Taxewell, Va., and the mouth, near Kingston, Tenn., is approximately 360 miles, measured along the river axis. About 64 percent of the sub-basin, or 2,810 square miles, lies within the State of Tennessee. The remainder of the sub-basin is in the southwestern corner of Virginia. The Clinch River valley is bounded on the north and west by the Cumberland River valley, and on the south and east by the Holston River drainage sub-basin.

Principal tributaries of the Clinch are the Powell River, draining 938 square miles, and the Emory River, draining 865 square miles. The Powell River valley closely parallels the main valley and is also a long, narrow area. The Emory River drains a short, fan-shaped valley at the lower end of the main basin in Tennessee.

The topography of the sub-basin varies from level valleys to rugged mountainous terrain. The northern edge of the sub-basin, bordering on the Cumberland Plateau, is mountainous.

Economic Development - Coal mining is an important industry in the mountains. Agriculture is the principal industry in the main valley. Manufacturing is carried on in a few towns, mostly in the lower portion of the valley in Tennessee. Harriman, on the Emory River, is the site of a large paper mill. The Atomic Energy Commission maintains and operates an installation on the Clinch River at Oak Ridge. Other industries in the sub-basin include textile manufacturing, coal washing, quarrying, and food processing.

Rainfall and Run-off - Rainfall is abundant in the sub-basin, as elsewhere in the Tennessee Valley, averaging about 54 inches per year. The precipitation is distributed fairly uniformly throughout the year, a factor of some importance in maintaining flows at all seasons.

Stream flows in the Clinch River valley are substantial, averaging over one cubic foot of surface run-off per second per square mile. The gaging station on the Clinch River near Scarboro, Tenn., 41 miles downstream from Norris Dam, has recorded an average flow of 4,294 cubic feet per second over a period of 11 years. The minimum recorded daily discharge at this station, which is regulated by Norris Reservoir, was 131 cubic feet per second. The U.S. Geological Survey has published a considerable amount of additional data on run-off in the Clinch drainage area.

Major River Developments - Norris Dam is the only hydroelectric project located in the Clinch River Sub-Basin. In addition to the power supplied by the project, the large reservoir, with a capacity of 2,567,000 acre-feet, affords considerable control over floods in the lower Clinch River valley. It also contributes to flood control in the Tennessee, Ohio, and Mississippi Rivers.

A corollary benefit of the Norris Dam project is the increase of flows below the dam during periods of low flow, thus providing additional dilution to waste materials discharged to the surface streams. The dilution factor is always important in deciding the degree of treatment necessary to be applied to wastes before discharge to streams.

Population - The population in the Clinch Valley is predominantly rural and is scattered throughout the sub-basin in many small towns and hamlets. According to the 1940 Census, the total population of the sub-basin was 277,891. The average population density in 1940 was approximately 63 persons per square mile. There are 48 communities listed as contributing significant waste loads to the streams at the present time. These 48 communities had a 1940 combined population of about 62,700.

Water Uses - Most of the communities in the Clinch River valley that have public water supplies use ground water. Surface streams are used by 16 communities in the sub-basin as a source of all or part of their required water. These water systems serve an estimated population of 32,286, not including Oak Ridge, Tenn., for which there are no data available.

The use of surface water by industries, other than that obtained from public water systems, is small. Surface water is used throughout most of the sub-basin for livestock watering.

Recreation is an important use of the Clinch River and its tributaries. Norris Lake is used extensively for boating, swimming, and sport fishing, and many streams in the valley have great recreational value.

Sources of Pollution - By far the greatest part of the pollution in the Clinch River comes from the town of Harriman on the Emory River. The paper mill located there is a heavy contributor of industrial wastes with practically no treatment. There is some effort to control waste discharges, however. It is reported that during the summer months about 90 percent of the wastes from this plant is barged directly to the Tennessee River.

Other lesser sources of industrial pollution in the Clinch River valley include a textile mill and a cannery at Clinton. Information on the amounts and kinds of waste discharged to the Clinch from Oak Ridge is unavailable. Acid mine drainage contributes significantly to the pollution of the streams in the sub-basin, although the problem is not as great as in some sub-basins where coal mining is more widespread.

There are no large cities in the Clinch drainage sub-basin. Domestic sewage from the 48 communities previously mentioned is scattered throughout the area. At the present time problems created by domestic pollution in this sub-basin are local in character.

Effect of Pollution on Water Uses - The effects of the waste discharges at Harriman are considerable. Industrial pollution from the paper mill reduces the quality of water in the Emory River arm of Watts Bar pool, decreasing its value as a source of water supply. Harriman has had trouble in treating its public water supply. Most of the other damages are local in character and affect such uses as industrial water supply and recreational uses.

Treatment Provided - Four primary treatment plants treat sewage from four municipalities having a population served of 3,592. Two secondary treatment plants treat sewage from two municipalities having a population served of 1,800. Very little industrial waste is tributary to these municipal plants. Three of the municipal treatment plants are satisfactory, one is unsatisfactory, and the status of two are undetermined. Three of the nine sources of industrial pollution provide treatment of the waste. One of these is unsatisfactory and the status of two undetermined. Data with respect to treatment provided and adequacy of treatment are shown in Tables $C_{(5)}$, $D_{(5)}$, and $E_{(5)}$.

Treatment Plants Required - Table $G_{(5)}$ indicates treatment plant requirements in the sub-basin. Thirty new plants and one plant replacement are required at municipal sources of pollution. Requirements at 14 locations are undetermined. Four new plants and one plant replacement are required at industrial sources of pollution. Requirements at four industries are undetermined.

Tabular Data - Tables $A_{(5)}$ through $I_{(5)}$ present additional data relative to pollution in the sub-basin. Data on acid mine drainage are not included. While this type of waste is not of major significance in the sub-basin, further study should be made to determine requirements for its abatement.

Table $A_{(5)}$ - Sources of pollution - Municipal

Municipalities*	Sources of pollution (In number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (In terms of equivalent number of people) **
Having data on pollution load discharged to watercourse	41	42,745	41,765
Having population data available (Data on pollution load to watercourse incomplete or not available)	7#(.)	1,146#	Not applicable.
Total	48#(.)	43,891#	------------

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers.

** Includes industrial wastes discharged into municipal sewerage systems.

# Includes 4 communities having no comprehensive sewerage system, but for which population data are available. These 4 communities have an estimated combined population of 839.

(.) Includes Oak Ridge, Tenn. for which no domestic or industrial waste data are available.

Table $B_{(5)}$ - Sources of pollution - Industrial*

Industries	Sources of pollution (In number of plants)	Amount of pollution discharged to watercourse (In terms of equivalent number of people)
Producing organic wastes	5**	170, 840
Producing organic wastes	0	Undetermined.
Producing inorganic wastes	3	Not applicable.
Producing wastes of undetermined type	2(.)	Undetermined.
Total	9#	------------

* Industries having separate outlets and discharging wastes directly to watercourse.

** Includes one plant also producing inorganic wastes.

# Total adjusted to correct for duplication noted in footnote marked thus, *.

(.) Includes one plant not operating at present time.

Table $C_{(5)}$ - Existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	4	4	3,592
Secondary	2	2	1,800
No treatment	41**	------------	38,499**

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

** Includes 4 communities having no comprehensive public sewerage system, but for which population data are available. These 4 communities have an estimated combined population of 839.

The above table excludes Oak Ridge, Tenn., for which no domestic or industrial waste data or treatment data are available.

Table $D_{(5)}$ - Existing treatment facilities - Industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products --	2	1	1	0
Textile mill products --------	2	0	2	0
Paper and allied products ---	1	1	0	0
Coal mining ------	1	0	1	0
Coal washery-----	1	0	1	0
Other mining industries--------	1	1	0	0
Miscellaneous ----	1**	0	0	1
Total ----------	9	3	5	1

* Industries having separate outlets and discharging wastes directly to watercourse.

** Oak Ridge, Tenn. No data available.

Table $E_{(5)}$ - Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	6	3	1	2	2	2	2
Industrial	3	0	1	2	1	0	2

Table $F_{(5)}$ - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (In terms of equivalent number of people)
1946	0	-------------	0	------------
1947	0	-------------	0	------------
1948	0	-------------	0	------------
1949	0	-------------	0	------------

Table $G_{(5)}$ - Requirements for municipal and industrial waste treatment plants

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	30	35,397	4
Enlargement or additions to existing plant	0	-------------	0
Replace existing plant	1	1,800	1
No project required	3	3,300	0
Undetermined	14* #	3,394*	4#

* Includes 4 communities having no comprehensive sewerage system, but for which population data are available. These 4 communities have an estimated combined population of 839. # Includes Oak Ridge, Tenn. for which no domestic or industrial waste data are available.

Table $H_{(5)}$ - Status of treatment works project to abate pollution - July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	16	5
Abatement ordered	0	1
Plans under preparation	6	1
Final plans approved	0	0
Construction awaiting financing	1	0
Under construction	3	0
Status undetermined	19	2

Table $I_{(5)}$ - Project list - Municipalities and industries requiring improvements for abatement of pollution - July 1, 1950

Name	Population served *	Project requirements	Remarks
Virginia:			
North Tazewell--	900	New plant ---	------------
Pounding Mill Quarry Corp. ---	-----------	Undetermined.	------------
Cedar Bluff ----	300	New plant ---	------------
Richlands ------	2,200	New plant ---	------------
Clinch Valley Clinic Hospital--	150	Undetermined.	Richlands.
Cleveland ------	200	Undetermined.	------------
Castlewood -----	200	New plant ---	------------
St. Paul -------	1,400	New plant ---	------------
Clinchport -----	300	New plant ---	------------
Tazewell -------	1,350	New plant ---	------------
Raven ---------	30	Undetermined.	------------
Honaker -------	825	Undetermined.	------------
Lebanon -------	1,000	Undetermined.	------------
Wilder ---------	35	Undetermined.	------------
Dante ----------	500	New plant ---	------------
Clinchfield Coal Corp. ----------	-----------	New plant ---	Dante.
Glamorgan -----	100	Undetermined.	------------
Norton --------	4,000	New plant ---	------------
Wise ----------	650	New plant ---	------------
Toms Creek ---	165	Undetermined.	------------
Coeburn -------	800	New plant ---	------------
Dorchester -----	50	Undetermined.	------------
Appalachia -----	2,800	New plant ---	------------
Big Stone Gap --	3,000	New plant ---	------------
Dunbar---------	103	Undetermined.	No community sewerage system.
Stonega --------	400	New plant ---	------------
Andover -------	680	New plant ---	------------
Derby ---------	800	New plant ---	------------

(Table $I_{(5)}$ - Continued)

Table $I_{(5)}$ - (Continued)

Name	Population served *	Project requirements	Remarks
Roda ---------	225	New plant ---	------------
Osaka --------	340	New plant ---	------------
Exeter -------	59	Undetermined.	No community sewerage system.
Imboden ------	142	New plant ---	------------
Calvin --------	350	Undetermined.	No community sewerage system.
Pennington Gap-	1,280	New plant ---	------------
Bonnie Blue ---	327	Undetermined.	No community sewerage system.
Kemmerer Gem Coal Mines ----	300	Undetermined.	------------
St. Charles ----	200	New plant ---	------------
Jonesville -----	350	New plant ---	------------
Rose Hill -----	200	New plant ---	------------
Tennessee:			
Clinton -------	3,400	New plant ----	------------
Bush Brothers & Co. ---------	3,600	New plant ---	------------
Magnet Mills --	1,600	New plant ---	------------
Oak Ridge (Industrial) ----	-----------	Undetermined.	------------
Oak Ridge (Domestic) ----	-----------	Undetermined.	------------
Kingston ------	1,300	New plant ---	------------
Cumberland Gap	280	New plant ---	------------
La Follette ----	2,300	New plant ---	------------
Jacksboro -----	200	New plant ---	------------
Norris Creamery	340	Replace existing plant	------------
Crossville ----	1,800	Replace existing plant	------------

(Table $I_{(5)}$ - Continued)

Table I(5) - (Continued)

Name	Population served*	Project requirements	Remarks
Brush Mountain Prison --------	800	New plant ---	------------
Harriman -----	4,100	New plant ---	------------
Cumberland Gap Woolen Mills --	------------	Undetermined.	Not operating at last report.
Mead Corp. ---	165,000	New plant ---	Paper mill - during summer, 90 percent of waste barged to Tennessee River.

* Organic industrial waste load is expressed in terms of population equivalent as measured by B. O. D.

HIWASSEE RIVER SUB-BASIN

General Description - The Hiwassee River originates in northwestern Georgia, flows across the southwestern corner of North Carolina and joins the Tennessee River in south central Tennessee. The principal tributaries are the Ocoee River (called the Tocoa River in Georgia) and the Nottely River. The area of the sub-basin is 2,800 square miles, 1,310 square miles being in Tennessee, 650 in North Carolina, and 840 in Georgia. The area is principally mountainous and the streams have steep gradients.

Economic Development - Agriculture is the chief industry in the sub-basin. Other industries include textile mills, chemical plants, and copper mining and refining.

Rainfall and Run-off - The average annual precipitation for the sub-basin as a whole is about 57 inches. Low flows in the main stem and part of the two major tributaries are regulated by reservoirs as described in the following paragraph.

Major River Developments - Eight dams and reservoirs have been constructed or acquired in the sub-basin by the Tennessee Valley Authority for flood control, navigation, and power purposes. Also, the lower end of the river lies in the upper end of a reservoir on the Tennessee River. Operation of these reservoirs for power purposes governs low-flow conditions downstream. However, in view of the present low quantity of organic waste entering the streams below the regulating points, there appear to be no special problems involved in correlating operation of the reservoirs with dilution requirements for organic wastes. Reservoir operation is important with respect to treatment requirements for acid wastes discharged by industry.

Population - The 1940 population of the sub-basin was 129,432. The 1940 population in municipalities contributing significant wastes to the streams was about 31,000. Influx of people during the vacation season increases these populations to some extent.

Water Uses - Waters in the sub-basin are used for industrial and domestic water supplies and for fishing, bathing and other forms of recreation. There are four public water supplies from surface sources and these serve a population of about 5,300. These are all located upstream in North Carolina and Georgia. The sub-basin lies in the Smoky Mountain area in which national forests are located. This area attracts visitors for vacation and recreational purposes and preservation of the recreational uses of the waters is highly desirable.

Sources of Pollution - Twelve municipalities in the sub-basin contribute an estimated waste load of 25,900 population equivalent to the streams. Five industrial plants contribute a waste load of 2,300 population equivalent. Three industrial plants contribute inorganic wastes. The only industrial wastes of any consequence are the acid waste discharge from the Copper Hill mining and refining processes and the high silt load resulting from this industry.

Effects of Pollution on Water Uses - Public water supplies are affected very little by pollution due to their upstream location. Minor pollution occurs in Hiwassee Lake above water intakes and needs correction. The pollution in the sub-basin causes damages which are mostly local in character, there being no widespread downstream damages. The major problem in the sub-basin is the reduction of waste from the Copper Hill mining and refining industry.

Treatment Provided - Six primary treatment plants serve six municipalities and a connected population of 7,095. One secondary treatment plant serves one municipality and a connected population of 10,500. The population connected to treatment plants is about 71 percent of the total population served by municipal sewerage systems. One of the municipal plants is satisfactory, four are unsatisfactory, and the status of two are undetermined. Only one of the eight industrial plants provides waste treatment and revisions are needed at this plant. Tables $C_{(6)}$, D(6), and E(6) present data relative to existing treatment facilities.

Treatment Plants Required - Table $G_{(6)}$ indicates treatment plant requirements in the sub-basin. Four new plants, three enlargements or additions to existing plants, and one plant replacement are required at municipal sources of pollution. Requirements at three locations are undetermined. New treatment plants are required at six industrial sources of pollution. Waste treatment facilities at one industry require additions. Requirements at one location are undetermined.

Tabular Data - Tables $A_{(6)}$ to $I_{(6)}$ present additional data relative to pollution in the sub-basin.

Table A (6) - Sources of pollution - Municipal

Municipalities*	Sources of pollution (In number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (In terms of equivalent number of people) **
Having data on pollution load discharged to watercourse	12#	24,875#	25,930#
Having population data available (Data on pollution load to watercourse incomplete or not available)	0	--------	Not applicable.
Total	12#	24,875#	----------

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers.

** Includes industrial wastes discharged into municipal sewerage systems.

# Includes data for one community having no comprehensive public sewerage system, but for which estimates of population and pollution loads discharged to streams are available. This community has an estimated population of 500.

Table B(6) - Sources of pollution - Industrial*

Industries	Sources of pollution (In number of plants)	Amount of pollution discharged to watercourse (In terms of equivalent number of people)
Producing organic wastes	5	2300
Producing organic wastes	0	Undetermined.
Producing inorganic wastes	3	Not applicable.
Producing wastes of undetermined type	0	Undetermined.
Total	8	-------------

* Industries having separate outlets and discharging wastes directly to watercourse.

Table $C_{(6)}$ - Existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	6	6	7,095
Secondary	1	1	10,500
No treatment	5**	--------------	7,280**

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers. ** Includes one community having no comprehensive public sewerage system, but for which population data are available. This community has an estimated population of 500.

Table $D_{(6)}$ - Existing treatment facilities - Industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products ----------	1	0	1	0
Textile mill products ----------	4	0	4	0
Chemical and allied products ----	2	1	1	0
Fabricated metal products ----------	1	0	1	0
Total ----------	8	1	7	0

* Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_{(6)}$ - Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	7	1	4	2	5	0	2
Industrial	1	0	1	0	1	0	0

Table $F_{(6)}$ - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (In terms of equivalent number of people)
1946	0	-------------	0	-------------
1947	0	-------------	0	-------------
1948	0	-------------	1	Inorganic.
1949	0	-------------	0	-------------

Table $G_{(6)}$ - Requirements for municipal and industrial waste treatment plants

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	4	6,780	6
Enlargement or additions to existing plant	3	5,275	1
Replace existing plant	1	10,500	0
No project required	1	1,020	0
Undetermined	3 *	1,300 *	1

* Includes data for one community having no comprehensive public sewerage system, but for which population data are available. This community has an estimated population of 500.

Table $H_{(6)}$ - Status of treatment works project to abate pollution - July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	6	7
Abatement ordered	0	0
Plans under preparation	0	0
Final plans approved	0	0
Construction awaiting financing	0	0
Under construction	0	1
Status undetermined	5	0

Table I$_{(6)}$ - Project list - Municipalities and industries requiring improvements for abatement of pollution - July 1, 1950

Name	Population served *	Project requirements	Remarks
Tennessee:			
Etowah	4,800	Enlarge existing facilities.	------------
T. E. Epperson Co.	1,400	New plant	Packing plant.
Copper Hill	1,500	New plant	------------
Copper Hill (Company area)	260	New plant	------------
Tennessee Copper Co.	------------	Add to existing facilities.	Manufacturing sulphuric acid.
Athens	3,500	New plant	------------
Athens Hosiery Mill	100	New plant	------------
Athens Stove Works	------------	Undetermined.	Metal industry.
Van Raalte Co.	500	New plant	Textile plant.
Cleveland	10,500	Replace existing facilities.	------------
Cleveland Tenn. Enamel Co.	-----------	New plant	Paint Company.
Crescent Hosiery Mill	200	New plant	------------
Tennessee Hosiery Mill	100	New plant	------------
Georgia:			
Young Harris	500	Undetermined.	------------
Blue Ridge	600	Undetermined.	------------
McCaysville	200	Undetermined.	------------
North Carolina:			
Hayesville	300	Add to existing facilities.	------------
Andrews	1,520	New plant	(Additional ind. (waste pop. equiv. (2,100.
Murphy	175	Add to existing facilities.	

* Organic industrial waste load is expressed in terms of population equivalent as measured by B.O.D.

ELK RIVER SUB-BASIN

General Description - The Elk River Sub-Basin is located in south central Tennessee and north central Alabama. It is a long narrow sub-basin and drains approximately 2,249 square miles, of which 2,002 square miles are in Tennessee and 247 square miles are in Alabama. The headwaters originate in the western scarp of the Cumberland Plateau, but soon drop to the Highland Plain which is characterized by rolling country and steep valleys. The Elk River enters the main stem of the Tennessee River in the backwater of Wheeler Dam about six miles above the dam site.

Economic Development - The principal pursuits in the sub-basin are agriculture and some industry dependent on agricultural products. A small amount of phosphate mining is carried on in the Richland Creek area.

Rainfall and Run-off - The average annual precipitation in the sub-basin varies between 50 and 54 inches per year, with the higher rainfall occurring in the eastern section of the sub-basin which is more mountainous. Available stream flow data indicate that the average flow at the mouth of the Elk River is in excess of 3,700 c.f.s. The minimum flow at this point was 85 c.f.s., while the maximum flow was 61,600 c.f.s. The flow on Richland Creek, one of the major tributaries of the Elk, has dropped to 28 c.f.s. during the minimum month.

Major River Developments - There are no major river developments in the sub-basin. Two low-level power dams are located on the main stem of the Elk River below Fayetteville and at Estill Springs. One storage dam has been proposed on the main stem for industrial water use.

Population - The 1940 population of the sub-basin was 101,752. Of this number, 20,632 resided in municipalities contributing waste to the streams.

Water Uses - Two municipalities in the sub-basin use surface water supplies. The 1940 population of these two municipalities was 9,998. Surface water is also used for three industrial supplies. The industrial consumption of water from surface sources is 6.075 M. G. D. Recreational uses of the surface waters include bathing, boating and game fishing.

Sources of Pollution - Eight municipalities serving an estimated population of 21, 150 contribute significant wastes to the streams. The total B. O. D. population equivalent discharged to the watercourses from these eight municipalities is 19, 160. Three industrial plants discharge wastes with an estimated population equivalent of 640 directly to the streams. One other plant discharges an undetermined amount of organic waste and two plants discharge inorganic wastes.

Effects of Pollution on Water Uses - In general the pollution problem on the main stem of the river cannot be considered of great magnitude. The most serious pollution problems are on the tributary streams, where local pollution problems occur over comparatively small stream stretches. An improvement in the quality of the Elk River below Fayetteville can be expected when the recommended sewage treatment works are provided. Improvements in the tributary streams for boating, fishing, recreation and stock watering can also be expected by the elimination of pollution now being discharged to the streams.

Treatment Provided - Six primary treatment plants and one secondary plant have been installed at sources of pollution. These serve a population of 15, 750. One municipality, with a population served of 5, 400 has no treatment. Due to industrial wastes connected to municipal systems, the wastes discharged after treatment are almost equivalent to the population served. Four industrial plants have waste treatment facilities, three being satisfactory and one unsatisfactory.

Treatment Plants Required - Requirements at municipal sources of pollution include one new plant, one enlargement, and four replacements. Requirements at industrial sources of pollution include additional treatment at one location. Requirements at one location are undetermined.

Tabular Data - Tables $A_{(7)}$ through $I_{(7)}$ present data relative to pollution of the waters of the sub-basin.

Table $A_{(7)}$ - Sources of pollution - Municipal

Municipalities*	Sources of pollution (In number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (In terms of equivalent number of people) **
Having data on pollution load discharged to watercourse	8	21,150	19,160
Having population data available (Data on pollution load to watercourse incomplete or not available)	0	0	Not applicable.
Total	8	21,150	------------

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers.

** Includes industrial wastes discharged into municipal sewerage systems.

Table $B_{(7)}$ - Sources of pollution - Industrial*

Industries	Sources of pollution (In number of plants)	Amount of pollution discharged to watercourse (In terms of equivalent number of people)
Producing organic wastes	3	640
Producing organic wastes	1	Undetermined.
Producing inorganic wastes	2	Not applicable.
Producing wastes of undetermined type	0	Undetermined.
Total	6	-------------

* Industries having separate outlets and discharging wastes directly to watercourse.

Table $C_{(7)}$ - Existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	6	6	10,350
Secondary	1	1	5,400
No treatment	1	--------------	5,400

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

Table $D_{(7)}$ - Existing treatment facilities - Industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products ---------	3	1	2	0
Chemical and allied plants ------	3	3	0	0
Total ---------	6	4	2	0

* Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_{(7)}$ - Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satis-factory	Unsatis-factory	Unde-termined	Satis-factory	Unsatis-factory	Unde-termined
Municipal	7	2	5	0	7	0	0
Industrial	4	3	1	0	4	0	0

Table $F_{(7)}$ - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (In terms of equivalent number of people)
1946	0	------------	0	------------
1947	0	------------	0	------------
1948	0	------------	1	Inorganic.
1949	0	------------	0	------------

Table $G_{(7)}$ - Requirements for municipal and industrial waste treatment plants

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	1	5,400	0
Enlargement or additions to existing plant	1	200	1
Replace existing plant	4	9,400	0
No project required	2	6,150	4 *
Undetermined	0	0	1

* Includes one plant which now has no treatment.

Table $H_{(7)}$ - Status of treatment works project to abate pollution - July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	6	2
Abatement ordered	0	0
Plans under preparation	0	0
Final plans approved	0	0
Construction awaiting financing	0	0
Under construction	0	0
Status undetermined	0	0

Table I(7) - Project list - Municipalities and industries requiring improvements for abatement of pollution - July 1, 1950

Name	Population served*	Project requirements	Remarks
Tennessee:			
Fayetteville ---	5,500	Replace existing plant.	------------
Monteagle -----	1,100	Replace existing plant.	------------
Girls' Vocational School --------	200	Enlarge existing facilities.	------------
Cowan --------	500	Replace existing plant.	------------
Winchester ----	2,300	Replace existing plant.	------------
Pulaski -------	5,400	New plant ---	------------
Mid-Tenn. Rendering Co.--	300	Add to existing facilities.	------------
Jack Daniel Distillery -----	------------	Undetermined.	------------

---

* Amount of industrial organic waste is reported in terms of population equivalent as measured by B. O. D.

DUCK RIVER SUB-BASIN

General Description - The Duck River is located in south central Tennessee just north of the Elk River Sub-Basin and south of the Cumberland River Sub-Basin. The sub-basin drains 3, 500 square miles wholly within Tennessee. It is a long sub-basin, narrow at the headwaters and widening as the river approaches its mouth. The area through which the Duck River flows is generally rolling agricultural land with no mountainous or particularly rugged terrain. The river has two large tributaries, the Buffalo River with a drainage area of 764 square miles and the Piney River with a drainage area of 223 square miles.

Economic Development - The principal economic pursuits in the sub-basin are agriculture and the mining and processing of phosphates. Canning, milk, textile and chemical industries are located in the sub-basin. Most of the industrial activity is centered around Shelbyville, Columbia and Mt. Pleasant.

Rainfall and Run-off - The average annual precipitation in the sub-basin is about 52 inches, varying from 48 inches in some sections of the sub-basin to 56 inches in other sections. The precipitation is reasonably well distributed over the sub-basin. Available stream flow data indicate that the minimum instantaneous flow at Hurricane Mills near the mouth of the river was 185 c. f. s. Regulation of flow is practiced at Manchester, where the minimum instantaneous regulated flow has been 5 cubic feet per second and at Columbia, where the minimum instantaneous regulated flow has been zero cubic feet per second. The minimum monthly flow at the above-mentioned stations has been 15, 61, 726, and 1, 848 cubic feet per second. Flows on the Buffalo River at Lobelville average 1, 100 cubic feet per second, with a record of minimum instantaneous flow of 142 cubic feet per second. Flows on the Piney River at Vernon average 264 cubic feet per second, with a record of a minimum instantaneous flow of 35 cubic feet per second.

Major River Developments - There are no major developments in the sub-basin. Two small hydroelectric power developments are located on the main stem of the Duck River, at Shelbyville and Columbia, and a number of small dams are in existence for industrial water supplies and other miscellaneous uses. Several small dams are also in existence on the Buffalo River.

Population - The 1940 population of the sub-basin was 130, 399. The 1940 population in communities contributing significant wastes to the streams was 28, 733.

Water Uses - Four public water supplies from surface sources serve five municipalities and an estimated population of 27, 700. Thirteen industrial establishments using approximately 42.7 M.G.D. have private surface water supplies. Other industries buy water from cities having surface water supplies. Other uses of the surface waters in the sub-basin include game fishing, bathing and boating.

Sources of Pollution - Eight municipalities serving an estimated 27, 000 people contribute significant wastes to the streams. These eight municipalities, because of industrial wastes in the municipal sewers, contribute a load equivalent to 53, 950 people. Nine industrial plants discharge organic wastes equivalent to 57, 320 people, while one plant discharges organic waste of undetermined amount. Fourteen plants discharge inorganic wastes directly to the streams. The inorganic wastes consist mainly of silt from the processing of phosphate ores.

Effects of Pollution on Water Uses - During periods of low stream flow, the main river at and below Columbia is grossly polluted, while at other points both the main stream and tributary streams are in poor condition. Silt pollution from the plants producing phosphates has caused damage to fish life at times, and the elimination of fish life from certain areas has occurred due to extensive silting of stream beds. Correction of pollution may be expected to prevent or minimize the danger to the various uses of the streams already noted. Additional use of the streams can be made for recreation, fishing, water supplies and other purposes.

Treatment Provided - Two of the municipalities, serving a population of 2, 900, have primary treatment; two serving a population of 8, 100, have secondary treatment; and three serving a population of 16, 000, have no treatment. Columbia, one of the municipalities with no treatment, serves a population of 9, 000, but discharges wastes equivalent to a population of 42, 000 due to connected industrial wastes. Thirteen of the 23 industrial plants have treatment facilities. Eleven of these are at chemical and fertilizer plants. There is very little reduction of the organic waste load by treatment. One of the municipal treatment plants is satisfactory and three are unsatisfactory. Seven of the industrial treatment facilities are satisfactory and six unsatisfactory.

Treatment Plants Required - Four new municipal treatment plants, one enlargement, and one addition are required. Another plant is needed to replace the existing facilities in one community. Eight new treatment plants are required at industrial establishments and four industries require enlargements or additions. Table $G_{(8)}$ indicates treatment plant requirements in the sub-basin.

Tabular Data - Tables $A_{(8)}$ through $I_{(8)}$ contain data relative to pollution of the waters in the sub-basin.

Table $A_{(8)}$ - Sources of pollution - Municipal

Municipalities*	Sources of pollution (In number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (In terms of equivalent number of people) **
Having data on pollution load discharged to watercourse	8	27,000	53,950
Having population data available (Data on pollution load to watercourse incomplete or not available)	0	0	Not applicable.
Total	8	27,000	------------

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers, or other population centers. ** Includes industrial wastes discharged into municipal sewerage systems.

Table $B_{(8)}$ - Sources of pollution - Industrial*

Industries	Sources of pollution (In number of plants)	Amount of pollution discharged to watercourse (In terms of equivalent number of people)
Producing organic wastes	9 **	57,320
Producing organic wastes	1	Undetermined.
Producing inorganic wastes	14	Not applicable.
Producing wastes of undetermined type	0	Undetermined.
Total	23 #	------------

* Industries having separate outlets and discharging wastes directly to watercourse. ** Includes one plant also producing inorganic wastes. # Total adjusted to correct for duplication noted in footnote marked thus, **.

Table $C_{(8)}$ - Existing treatment facilities - Municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	2	2	2,900
Secondary	2	2	8,100
No treatment	4	--------	16,000

* Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

Table $D_{(8)}$ - Existing treatment facilities - Industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products----	8	2	6	0
Textile mill products ----------	1	0	1	0
Chemical and allied products -----	13	11	2	0
Products of petroleum and coal ------	1	0	1	0
Total ----------	23	13	10	0

* Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_{(8)}$ - Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	4	1	3	0	3	1	0
Industrial	13	7	6*	0	10	3	0

* Includes two plants which are listed in Table $G_{(8)}$ under "No Project". Correction can be obtained by improved operation.

Table $F_{(8)}$ - Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (In terms of equivalent number of people)
1946	0	---------	0	---------
1947	0	---------	1	1, 500
1948	0	---------	1	1, 100
1949	0	---------	0	---------

Table $G_{(8)}$ - Requirements for municipal and industrial waste treatment plants

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	4	16, 000	8
Enlargement or additions to existing plant	2	7, 600	4
Replace existing plant	1	1, 700	0
No project required	1	1, 700	10 *
Undetermined	0	0	1

* Includes one plant which now has no treatment.

Table $H_{(8)}$ - Status of treatment works project to abate pollution - July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	4	9
Abatement ordered	0	0
Plans under preparation	1	1
Final plans approved	0	1
Construction awaiting financing	2 **	1 *
Under construction	0	0
Status undetermined	0	1

* To be connected to municipal plant now awaiting financing. ** One of these now awaiting financing. Present plans contemplate treatment of both sources of pollution at one plant.

Table I(8) -Project list - Municipalities and industries requiring improvements for abatement of pollution - July 1, 1950

Name	Population served *	Project requirements	Remarks
Tennessee:			
Shelbyville	5,000	New plant	Textile wastes.
McGill Knitting Co.	120	New plant	Dye waste.
Shelbyville Mills	800	New plant	Sanitary wastes. (classed as munic.)
Columbia	9,000	New plant	Textile wastes.
Tennessee Valley Packing Co.	5,000	New plant	--------------
Parks & Harris Packing Co.	2,500	New plant	--------------
National Carbon Co.	0	New plant	Phenolic wastes.
Centerville	1,200	New plant	--------------
Carnation Co. (Manchester)	600	New plant	--------------
Carnation Co. (Bell Buckle)	200	New plant	--------------
Lewisburg	6,400	Enlarge existing facilities.	--------------
TVA Godwin Plant	0	Enlarge existing facilities.	Acid wastes.
International Mineral & Chem. Co.	0	Enlarge existing facilities.	--------------
Va.-Car Chem. Corp. (Mining Dept)	0	Enlarge existing facilities.	--------------
Dickson (part)	1,700	Replace existing facilities.	(1,700 to Duck Riv. (1,700 to Cumberland.
Tenn. Products & Chem. Co.	42,000	New plant	Phenolic wastes. from wood distillation.
Hohenwald	1,200	Add to existing plant.	--------------
Old Black Joe Co.	500	New plant	Cannery.
Wayne Creamery Co.	700	Add to existing plant.	--------------
McEwen Canning Co.	0	Undetermined.	Recently reported out of operation.

* Amount of industrial organic waste is reported in terms of population equivalent as measured by B. O. D.